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NEW SERIES.

"It will flourish, if naturalists, chemists, antiquaries, philologers, and men of science, in different parts of *Asia* will commit their observations to writing, and send them to the Asiatic Society, in Calcutta; it will languish, if such communications shall be long intermitted; and will die away if they shall entirely cease."—SIR WM. JONES.

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JOURNAL

OF THE

ASIATIC SOCIETY.

Memoir on Indian Earthquakes. By Lieut. R. Baird Smith, *Bengal Engineers.*

Among the various Committees established by the British Association for the investigation of subjects of general scientific interest, one has been appointed to register Earthquake shocks in Great Britain, and its labours have already been made public in several Reports to the parent body. From the discussions consequent on the presentation of these Reports, it appears, that in the opinion of well qualified judges, results of but little comparative importance can be anticipated from observation made in localities, where the disturbing forces act with such feeble intensity as in those brought under the notice of the Committee, and it is therefore considered desirable, that similar observations should be made abroad, in tracts of country where greater energy characterises the disturbing powers, and where the effects of these are exhibited on a larger and more important scale. Several such tracts are to be found in India, and a few of the most remarkable convulsions experienced throughout them, are already familiar to scientific men. But no systematic effort has yet been made to record and analyse the various phenomena of Indian Earthquakes, and the narratives of these are scattered throughout the pages of various works, without connection and without method. To collect from every available source, all

the information connected with Earthquake shocks in India and its frontier countries, both in regard to those that have already occurred, and those that in future may occur, is the principal object proposed in this investigation. In regard to the historical portion of the subject, I cannot but feel conscious of its imperfections, since accounts of Indian Earthquakes are in general so meagre in important details, and must always be sought for under so many different sources, that to make the enquiry perfect, would require an amount of leisure and literary resources that very few, if indeed any, in this country, can command. In tracing the history of our Earthquakes, I have, however, done all I could with the materials at my disposal, and perhaps I may yet be able to complete what I now feel to be so imperfect.

More sanguine hopes of interesting results may, however, I think, be entertained in regard to Earthquakes that may be experienced after this time, since a general interest has been awakened in the subject, and the attention of many intelligent and well qualified observers attracted to it. Observations will moreover in future be centralised, and the unsatisfactory labour of gleaning information from many detached sources will be saved. Earthquakes are almost invariably observed when the feelings are excited, and emotions adverse to a calm, deliberate judgment on accompanying phenomena have sway. The greater the scale on which the disturbing forces are exhibited, the more intense will such feelings and emotions usually be, and in those very cases where minute and careful observations would be of the greatest value, observers are generally in a state the most unfavourable for making them. The sensible and permanent effects of Earthquake shocks are frequently detailed with painful minuteness, but those more temporary and evanescent, but at the same time, more immediately connected with the causes to which such convulsions are due, are allowed to pass by unobserved. The tendency to exaggerations induced by this state of mind requires constant allowances to be made for the statements of observers, and we shall be able to estimate the amount of this allowance only after the phenomena of Earthquakes have been brought to the test of actual measurement by the use of appropriate recording instruments. Such instruments have been brought into use by the Committee of the British Association, but they are yet far from being perfect; and before their full utility can be felt, their sensibility must be increas-

ed considerably beyond the point to which it has yet been carried. This will no doubt ere long be accomplished, and the details of the phenomena of Earthquake shocks be removed from the ill-defined province of feeling, and brought under that of measured space and number.

The chief obstacle to the introduction of such recording instruments as are alluded to above, throughout the Earthquake tracts of India, will probably be found in the incessant fluctuations of society, and the consequent impossibility of obtaining consecutive series of observations. In reflecting on this point, it has appeared to me, that the most permanent local establishments in the country are the mission stations, and that if Missionaries residing in favourable localities, could be induced to receive and record observations with our instruments, they would confer a boon upon science at a very trifling sacrifice of time or labour in the cause. Earthquakes usually occur at distant intervals, and the observations required upon them, are neither complicated nor laborious. I would therefore hope to obtain in course of time the co-operation of those members of favourably situated mission establishments, who may not be unwilling to devote a limited portion of their time and talents to the elucidation of what is certainly one of the most interesting chapters of the physical history of India. Meanwhile, however, until arrangements can be matured for supplying instruments to those willing to receive them, I trust I shall continue to receive the interesting communications of those observers who have so zealously assisted me during the past year, and for whose aid I feel most grateful. Their individual labour will come more appropriately under notice in another page; but I am desirous of expressing to one and all, my acknowledgment of their valuable assistance, since to it must be traced all the interest that this investigation may possess.

To the gentlemen connected with the public press of India, especially to Messrs. Stocqueler and Place, Editors respectively of the *Calcutta Englishman* and *Delhi Gazette*, I am indebted for essential aid, and I trust I may continue to receive from them such notices of Earthquake shocks, as from time to time, may be made public in their papers.

My information relative to Earthquakes in the presidencies of Madras and Bombay is, I regret to say, extremely limited. In both there

are tracts occasionally subject to such shocks, and I would solicit the co-operation of observers under whose notice they may come.*

This Memoir will be divided into the four following parts:—

I. Register of Indian Earthquakes for the year 1842.

II. Historical Summary of Indian Earthquakes, with some remarks on the general distribution of subterranean disturbing forces throughout India and its frontier countries.

III. Analysis of the phenomena of Indian Earthquakes, as exhibited in the two preceding parts.

IV. Remarks on the points to be observed during Earthquake shocks, and on the means of making the requisite observations.

Part. I.—Register of Indian Earthquakes, during the year 1842.

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1. Jellalabad Earthquake of the 19th February, 1842.

My attention was first prominently attracted to the subject of Earthquakes in India, by the occurrence of that of the 19th of February last. A few brief and imperfect notes founded upon the details I was able to collect, were published in the Journal of the Asiatic Society and my object then was, more to direct attention to the subject of Earthquakes in general, than to furnish rigidly accurate conclusions on this case in particular. Such conclusions were indeed incompatible with the nature of the information furnished me, and I have subsequently ascertained, that many corrections of these are requisite. Yet the notes have fully answered their design, and have led to my procuring much information, which, had they not been published even with all their imperfections, would certainly have been lost to science. From the date of the Earthquake my register was commenced, and it is my intention to continue it regularly, publishing it at yearly intervals. I have some recollection of two Earthquakes having been experienced in Delhi during the month of January 1842, but unfortunately I did not record them at the time, my register not being then commenced, and I have been unable since to verify this im-

* All communications on the subject of Earthquakes in India may be addressed to the author at Seharunpore, North-western Provinces, Bengal, or if preferred, to the Secretary to the Asiatic Society, Calcutta, or to any of the public papers.

pression. The Jellalabad Earthquake therefore comes first in order, in the year 1842.

In tracing the progress of this Earthquake, I purpose commencing at its most westerly limit, and following it to the Eastward. According to this plan, the first place where its effects are to be noticed is *Caboot*, (lat. 34° 30′ 30″; long. 69° 7′ E.) The intelligence from Cabool is, however, extremely limited, being confined to the following short extract from a narrative of the events of the captivity at that city, by Dr. Berwick and his party of sick and wounded, left behind, when the British force attempted to retreat to Jellalabad.

"On the 19th of February," it is remarked, "they were visited by a most awful Earthquake. It continued for some minutes, and rocked the fort in a frightful manner. All the men able to move rushed out into the open air, every moment expecting the walls to fall in and bury them; but God was good, and after three minutes' duration, each shock succeeding the other in rapid succession, it ceased. The walls were dreadfully shaken, especially the side wall of the European ward, which came down a few days afterwards." From the effect of the shock, as detailed in this extract, it may safely be inferred, that Cabool did not form its extreme westerly limit, but we have no authentic intelligence of its progress beyond that place, and its would therefore be vain to speculate upon the point.

Proceeding Eastward over a tract of country more rugged and inhospitable than can well be conceived, and descending from a height of about 7,000 to a little more than 2,000 above the level of the sea, we enter the valley of Jellalabad, where the devastating effects of the Earthquake were exhibited on a larger scale than at any other place. The whole line of the Cabool river from Cabool to Jellalabad, experienced, however, the effects of the shock, and many of the forts of the chiefs were laid in ruins, or seriously injured. Among others, that of Budiabad, in which the English prisoners were then confined was, I am informed, much shaken, although not destroyed.

The valley of Jellalabad is thus briefly described by Lieut. Wood of the Indian Navy:—"A ridge of hills called Deh Koh, or the black mountain, rises about Jugdulluck and running East by North till it meets the Cabool river, bounds the plain of Jellalabad on the North; to the South it has the high hill of Nungnihar; East it has the hills of Alee

Baghan and desert of Buttee Kote; while its Western limit is marked by ridges, which here project into the valley of the Soorkh Rood. The length of the Jellalabad plain is 25 miles, and its width does not exceed four miles."

The town of Jellalabad (lat. 34° 25′; long. 70° 30′*) was garrisoned at the period of the Earthquake by General Sir Robert Sale's Brigade, and hence our information as to the effects of the shock is in considerable detail. The following extract from the *Englishman*, gives the most graphic account of the Earthquake I have yet seen.

Extract from a letter published in the Calcutta Englishman of the 16*th May* 1842, *dated Jellalabad,* 28*th April,* 1842.

"On the 19th February, we had one of the most awful Earthquakes I have ever experienced; it occurred at mid-day, being very stormy at the time, with clouds of dust floating through the atmosphere. The shock lasted about a minute and a half, and commenced with a sound like the rolling of a heavy waggon over a wooden bridge—the earth swung to and fro like the rocking of a cradle; not a man could keep his legs; every one fell prostrate, and a sensation of sickness and giddiness affected all. Bastions and houses came tumbling down with a dreadful crash, and we verily believed we were about to be swallowed up in some yawning chasm. The earth did open in several places, and water appeared on the surface of the ground. The river was thrown into the most violent commotion, and the water dashed over its bank with frightful violence. I was standing on a bastion at the time, it split in two places and crumbled down; I was precipitated to some distance, where I lay stunned and stupified with horror. No one could utter a word, and every face was blanched with terror and apprehension; here was death in a new form, for which we were totally unprepared. Providentially for us, not a man of our party was killed; many were injured by the falling of the houses, but none dangerously: a few of the inhabitants of the town were killed, where the fall of the high houses choked up the street, and left no room for escape; but on the whole the accidents were few, compared to the nature and extent of the mischief. From this period until the

* The positions of places in Affghanistan, are taken from Walker's New Map.

middle of March, we had frequent slight shocks, sometimes so many as six or seven during the twenty-four hours. Our fortifications were seriously damaged by this awful visitation, and we fully expected the enemy would have made a rush upon us, for there were gaps enough, but every precaution was taken to repel them. They hovered about us, however, like birds of prey, trying to ascertain the extent of our damage; whether they learnt it or not I cannot say, but seemingly they thought it better to let us alone. We fell to work again with renewed energy, and in a short time repaired much of the injury the works had sustained, labouring night and day without intermission, until we were once more able to set the enemy at defiance."

The appearance of water at the Earth's surface through fissures made by Earthquake shocks having been connected with theoretical considerations on the causes of the events,* I felt desirous of verifying the statement made in the above extract, that this phenomena was observed at Jellalabad, and I therefore wrote to my friend Major Broadfoot, C. B, requesting him to give me any information on the point he might possess. In reply, under date Jellalabad, 13th July 1842, he thus writes: "You ask where the water came from that issued from the cracks in the earth. I saw no water issue from the cracks which opened where I was, nor signs of any in others, and I saw more of the effects and sooner than perhaps any one else; nor do I remember hearing of water issuing from the earth at the time. Still it *may* have happened." And the nature of Major Broadfoot's duties gave him the best possible opportunities of observation, it is probable that had water actually been ejected from the earth, the circumstance would not have escaped his notice, and the statement that it did do so, must be considered as very doubtful.

A few further particulars of the Earthquake at Jellalabad are given in the following extract from Sir Robert Sale's official dispatch, dated Jellalabad, 16th April 1842: "But it pleased Providence, on the 19th of February, to remove in an instant this ground of confidence (alluding to the defensive works executed by Major Broadfoot for the protection of the city.) A tremendous Earthquake shook down all our parapets built

* On Hydrostatic Pressure as a cause of Earthquakes, by the Rev. John Toplis, B. D. Jameson's Journal, No. 59, p. 84.

up with so much labour, injured several of our bastions, demolished a third of the town, made a considerable breach in the rampart of a curtain in the Peshawur face, and reduced the Cabool gate to a shapeless mass of ruins. It savours of romance, but it is a sober fact, that the city was thrown into alarm, within the space of little more than one month by the repetition of full one hundred shocks of this terrific phenomenon of nature."

The Jellalabad Earthquake is here considered solely in its relations to science; but it may be permitted me to turn for a moment from the cold record of physical phenomena, and to express the admiration all must feel at the noble conduct of that gallant band, whose moral courage rose superior to the depressing influence of such a series of convulsions at such a crisis, and whose physical exertions so rapidly obliterated their devastating effects, that their wondering foes could attribute the result only to some supernatural agency, to some English witchcraft.

The superior intensity of the Earthquake in the immediate vicinity of Jellalabad, and the incessant state of "*tremblement*" into which the earth there was thrown for so long a period after the great shock, appear to me to render it almost certain, that the focus of disturbing force was situated in that valley, and that the undulations generated were propagated East and West from some point in it as a centre. Most of the shocks subsequent to the great one of the 19th February were local, and a very few only were felt at Peshawur to the Eastward, and none in so far as I know to the Westward. The disturbing force to which the series was due, must therefore have been confined in its action to the valley of Jellalabad, and the effects would indicate, that its focus was at no very great depth beneath the surface of the earth, and that farther, a large amount of its power was expended on the 19th, since the other shocks were feeble in comparison with the one experienced on that day.

From the best information I can procure, the time at which the Earthquake was felt at Jellalabad was 11h. 40m. A. M. All the times subsequently stated, will be reduced to Jellalabad time, so as to shew correctly the progress of the shock. This correction was neglected in my notes formerly published, in consequence of the very great discre-

pancies among the periods stated by different observers, and the impossibility of their knowing which were correct. Information subsequently obtained, has, however, admitted of greater certainty as to time, and greater care is therefore requisite in combining the observations.

From Jellalabad, the shock affecting a portion of the Suffeid Koh range of mountains, with the numerous subordinate ranges that diverge from it, reached the town of Peshawur, (lat. 34° 06′; long. 71° 42, E). From the circumstance of General Pollock's force having been encamped at Kawulsur, about eight miles from Peshawur, and the communication being uninterrupted, the details relative to the effects of the shock there, are fuller and more satisfactory than would otherwise have been the case.

The following extracts from letters published in the *Delhi Gazette*, give the most complete accounts of the effects of the Earthquake I have been able to find :—

Extract from a letter, dated Kawulsur, 20th February, 1842.

" Yesterday a fearful Earthquake visited this part of the world. The shock which came on————,* was long continued, and men, horses, tents, even the ground under us, and the hills in the distance, appeared to be moving. It was an awful visitation, and made every heart quake. In the direction of Peshawur, (eight miles distant,) clouds of dust appeared, which proved to have been caused by the falling of very many houses and buildings. A salute was fired from the battery at Jumrood, for the purpose of announcing the safety of Rajah Pertaub Sing, son of Maharajah Shere Sing, who is now at Peshawur, and of whom it is said he narrowly escaped death : the building in which he had been sitting came down almost immediately after he quitted it. The natives say a tenth of the city is down, and a number of the inhabitants killed."

Extract from a letter, dated Kawulsur, 19th February, 1843.

" It is now about 12 o'clock mid-day, and we have just experienced a most awful Earthquake in Camp. The natives say that nothing so severe of the kind has been experienced in India for the last fifty

* The time stated being erroneous, is omitted. The times generally are still by no means so satisfactory as is desirable.

years. The earth literally trembled like an aspen leaf, and rocked to and fro as an infant's cradle, or like a ship at sea. Many of the camels that were carrying the baggage of the troops to Col. Wild's camp were thrown down, and so great was the shock, which lasted fully five minutes, that I was obliged to support myself by holding on to the camp furniture, and many of the officers fancied themselves suddenly taken ill. I expected every moment to have seen the earth open and swallow us up, and it is only by God's great and merciful providence that we have escaped through such an awful convulsion of nature.

" Every one complains of nausea. We have just been observing immense volumes of dust, that completely darken the atmosphere in the direction of the old ricketty town of Peshawur, which is supposed to be nearly levelled with the ground, as the houses are but weakly built, being merely propped up by the beams of wood which may be observed placed in different spots under large walls and corners of the houses, and are even dangerous to passers-by at all times. I doubt not but to-morrow's dawn will bring us dreadful intelligence, and produce a fearful account of lives lost.—*20th February.* Reports say, that only from 40 to 50 persons at Peshawur were crushed and killed among ruins of the falling houses. General Avitabili's large dwelling house, which had recently been built, and was being finished, fell in, but luckily did no injury to any one in the house."

The period of the shock at Peshawur was 11h. 41m. 12s. Jellalabad time, the observed time at the former place being 11h. 46m. and the difference of longitude 4m. 48s.*

The course of the Earthquake hitherto has been through a tract of country rugged and mountainous in the extreme. The geology of the district extending from Cabool to Peshawur has never been satisfactorily described, and very little, I might indeed say nothing, whatever is yet known about it. Dr. Lord gives the following general remarks on the great features of the country, and some of the points alluded to by him, as indicating severe disruptive action, are interesting in con-

* Captain Lawrence, late Political Agent at Peshawur, assures me, he feels quite certain as to the period of the Earthquake at that place; he having been led to watch the time narrowly, in consequence of a meeting between General Pollock and Rajah Pertaub Sing being to take place at noon exactly, arrangements for which were in progress under his superintendence.

nection with the frequent occurrence of Earthquake shocks throughout the tract. The facts embodied in Dr. Lord's remarks, must be separated from the theoretical views with which they are associated, the latter being open to serious objections; but as there is reason to believe they are now under discussion by a very competent authority, it is unnecessary to allude farther to them here.

"A parallel of latitude," Dr. Lord remarks, "drawn through Kalabágh and west of the Indus would present a remarkable difference in the course of the mountain chains as observed to its north and south sides. In the latter direction, the Soliman and Kala ranges, the one of which may be looked upon as a continuation of the other, generally preserve an almost perfect parallelism with the course of the Indus; while on the other side every range, and they are numerous from the Himalaya and Hindu Kosh to the Salt range inclusive, are at right angles with the direction of the stream. In other words, the general line of the former is North and South, of the latter East and West. It is of the latter, and the country they include, that I would more particularly speak at present.

"In addition to the general course of the chains thus laid down, there is another fact, subordinate, yet of no less importance towards determining the physical formation of this part of the country. When the two mountain ranges have for some time preserved their parallel East and West course, the Northern is observed to deflect, or send off a branch towards the South, while a corresponding deflection or ramification of the Southern chain comes to meet it, and the plain which otherwise would have been one continued expanse from East to West, is thus cut into a number of valleys, the longitudinal axis of which, however, is still in general to be found in the same direction. If we conceive these valleys to be few, spacious, and well marked towards the North and South, while in the central or Cabul region they become small, numerous and crowded, so as to resemble a tangled maze or net-work, we shall have a just general conception of the tract of country west of the Indus, which may be familiarly described as lying between Cabul and Kalabágh.

"Unquestionable geological facts, such as the structure of igneous rocks poured out under strong pressure, the presence of fossil shells

&c. lead me to the belief that several, if not all of these valleys, were at some former time the receptacles of a series of inland lakes, and the natures of the shells found (principally planorbes and paludinæ) seem to indicate that the waters of these lakes had been fresh. In this manner three grand sheets of water, separated by the mountain deflections before alluded to, would appear to have occupied the entire country from Kabul to the Indus, and their basins may now be distinguished as the plains which afford sites to the three cities of Kabul, Jellalabad, and Peshawur.

" The draining of these basins is tranquilly carried on by the Kabul river, which runs along the northern edge of each, conveying their united waters to the Indus: but in former times when more energetic means were necessary, the mountain barriers burst, and the shattered fragments and rolled blocks that now strew the Kyber Pass, bear testimony to its once having afforded exit to a mighty rush of waters, while the Gidur-Gulla (or Jackall's neck,) a long defile east of the plains of Peshawur, clearly points out the further course of the torrent towards the bed of the Indus, whence its passage to the ocean was easy and natural."

The questions in pure geology involved in these remarks I do not concern myself with, but I have quoted them to shew, that indications of powerful disruptive forces prevail throughout the whole of the course of the Earthquake of the 19th February hitherto described, and this point is all that circumstances admit of being established. Of the nature of the rocks composing the mountain masses between Cabool and Jellalabad, I have seen no account. Major Broadfoot states, that the rocks in the immediate vicinity of Jellalabad are gniess, and Sir A. Burnes mentions, that mica slate and granite are also found there. Relative to the rocks in the Kyber Pass, my friend Lieut. Goodwyn of Engineers, writes thus: " The Kyber rocks are of flinty slate, varying in all degrees of hardness from flint to slate. Sometimes the rock is nearly one solid mass, the strata are so slightly defined, and they cannot be separated with a crow-bar—at other places, a blow of a pickaxe is sufficient to shiver it into fifty little cubes of slate; a considerable quantity of earth lying between the strata, which falls down in dust. Sir Alexander Burnes says, " The formation is a flinty slate overlying conglomerate, but

I have also frequently found the conglomerate overlying the slate, and they are frequently united in the same rock. The conglomerate is very hard, and we could not progress more than four inches an hour, with two-inch jumpers, in boring holes for blasting. The stones seem cemented with a sort of iron cement."

After leaving Peshawur, the shock traversing the alluvial plains of the Punjaub reached Ferozepore, (lat. 30° 56′ 50″ ; long. 74° 35′,) where its force was still felt to be severe, though no longer destructive. No accounts have been made public of the effects of the shock at any place intermediate between Peshawur and Ferozepore. The latter place was reached at 11h. 48m. 40s. A. M. Jellalabad time.

The city of Delhi, (lat. 28° 40′ ; long. 77° 16′,) is the next place from which we have authentic intelligence of the effects of the Earthquake. The intensity of the shock was, however, very much diminished here, and beyond the motion of the ground no other effects are alluded to. The period of the Earthquake at Delhi, as stated in my notes formerly published, I find to be erroneous, and the proper time from the best information I have been able to procure, is 11h. 53m. 56s. A. M. Jellalabad time. Relative to the nature of the shock at Delhi, Mr. Sub-Conductor Bingham of the Sappers and Miners thus writes : " The total duration of the shock, which appeared to me to consist of several distinct undulations of the earth, but without perceptible intervals between them, could not have been less than five or six minutes. But of this I cannot speak definitely, as I had no reference to a time-piece during the shock."

About twenty miles to the South-west of the city of Delhi, at a village called Sonub, is situated a hot spring, of which the following description is given anonymously in the second volume of the *Gleanings in Science*, p. 34 :—

" At Sonub near Delhi, there is a hot spring (sulphureous) which attracts from the surrounding country myriads of people for the purpose of bathing ; the bath is constantly filled with as many people as it can hold, (except perhaps for a few hours during the night,) in the day time by men, and the night time by women ; most of the inhabitants of the town itself are in the habit of bathing in it daily, and it is perhaps to this habit, that they are indebted for the cadaverous and

unhealthy appearance so common among them. The temperature of the spring in January last, (1829,) was 103° ; but it varies, for in July, 1826, I observed it as high as 110°. The flow of water also varies considerably."

Dr. Malcomson of Bombay, having made enquiries of Dr. Falconer, late Superintendent of the Botanic Garden, Seharanpore, as to whether this spring was affected by the Earthquake of the 19th February, the latter referred the question to me, and I availed myself of the assistance of my intelligent and indefatigable correspondent, Mr. Bingham, in instituting enquiries on the spot. Mr. Bingham applied first to the Deputy Collector of the district of Goorgaon, in which district the spring is situated, but so little interest was taken by him in the matter, that he did not even reply to Mr. Bingham's letter. This indifference, on the part of the Deputy Collector, was, however, compensated for by the interest and activity, shewn by Mr. H. Martin, the Superintendent of Roads in the same district, who so soon as applied to by Mr. Bingham, visited the spring, and addressed the following interesting letter to me, giving the results of his enquiries :—

Letter from Mr. H. Martin to my address, dated 15th October, 1842.

Sir,—Having been requested by Mr. Bingham, to obtain for you what information I could on the subject of the alterations which took place in the hot wells of Sonub. I yesterday visited them, and have much pleasure in transmitting to you the results of my enquiries, which I trust will prove of utility to the object you have in view.

"On the 19th February last, (the day of the Earthquake,) the water in the wells became as cold as that of the ordinary wells of this country —the issue of the spring was observed to flow much slower, and in less quantities than formerly, and at times the spring would be completely dry. No disturbance of any kind was visible, nor any other change than what I have noticed. The above appearances continued for twenty-five days, when the wells resumed their former state.

"I would remark, that this statement may be credited, as all to whom I applied answered with readiness, and from the length of time which the appearances lasted, there could hardly be a mistake.

"Should you wish for any more detailed particulars, or if I could be of any assistance to you in any way on any other subject that may

relate to this district, I shall be most happy in furnishing you with all the information I can procure." I am, &c. &c.

H. Martin.

In continuation on the same subject, Mr. Bingham writes under date 1st Nov. 1842:—

"I wrote some time ago to Mr. Martin, for information regarding the locality of the springs, and it appears from his reply, that they are situated within 200 yards, (but he does not state whether on the East or West side,) of a range of low hills, which I have myself formerly traced from where they cross the Jumna, about two miles to the north of Delhi, running in a southerly direction beyond Muttra.* There are no rocks in the immediate neighbourhood of the hot springs, but the hills are principally composed of a very hard stratified quartz stone, the strata dipping at an angle of 70° or 75°, with numerous vertical cracks and fissures through them, as if they had been suddenly and violently heaved up.

"There is also here and there a stone of different formation found lying upon the quartz; in some places, it is merely '*bujree*' (red sand,) in others a soft red sandstone. The city of Delhi is mostly built upon these rocks, and some years ago when employed in blasting to form a ditch for one of the bastions on the south side of the city, I had often occasion to remark the impressions of the roots and fibres of vegetables† in the same stone; but in the quartz rock, I never met with any foreign substances, except some slight traces of a metallic nature, which appeared to me to be zinc or copper."

As the Sonub hot spring in all probability rises through one of those fissures so common in the vicinity, the effect of the earthquake seems to have been to close this exit of the waters temporarily, as the supply diminished so much immediately afterwards. And the diminution of the supply would lead to the water becoming colder in consequence of its exposing a lesser bulk to the cooling influences of the strata

* These are the Aravulli range of hills, which abutting on the Western termination of the Vindyas, run up through Rajpootana, and are lost at some little distance to the Northward of Delhi.

† The nature and relations of this sandstone render it probable, that these vegetable forms were not the remains of actual vegetables, but were those dendritic forms of doubtful origin so common in similar circumstances.

through which it passed. The obstacle in the path of the waters, whatever its nature may have been, appears to have been wholly removed at the end of twenty-five days, as then the temperature and quantity of the water returned to its usual standard.

Continuing to the Eastward of Delhi, the next place from which intelligence was received relative to the effects of the shock, was Poojnah, a station on the Doab Canal, (lat. 29° 32′, long. 77° 27′?) where Sergeant and Assistant Overseer Renny observed and communicated to me the following detail:—

Extract of a letter from Sergt. Renny, dated Poojnah, 19th Feb. 1842.

"I also beg leave to inform you, that we felt a very severe shock of an Earthquake here at — *. It lasted about three minutes with intervals. My whole family felt it as well as the people about my place, who came running to me much alarmed. It was first noticed I believe by myself, as I was then sitting writing, and found a heavy table on which my desk was laid, much agitated, which I thought was caused by some one moving; but I soon found my chair in motion also, and on looking about, I perceived every thing moveable in the room in a state of agitation. A few hours before this, I observed the water in the canal was unusually muddy, and after the shock was over, I went to look and found it much disturbed by a high swell, whether occasioned by the shock or not, I cannot say."

Sergt. Renny is entitled to my best thanks for these interesting details. The unusual muddiness of the canal could not possibly have been due to the influence of the Earthquake, since the direction in which the shock travelled was against, not coincident with that of the current in the canal, hence the disturbance of the silt in the bed of the canal could not *precede* the shock; but it is quite possible, that the high swell observed *after the shock had passed*, may have been occasioned by it. The time of the shock at Poojnah was, as nearly as I can estimate it, 0h. 00m. 12s. P. M. Jellalabad time.

From Poojnah, the shock travelled to Saharanpore, where it was just felt, but attracted no particular attention. It was next experienced at Kulsea, another station on the Doab Canal, about twelve or fourteen miles to the Northward of Saharanpore, where its effects

* The time stated being erroneous, is omitted.

were very perceptible. The motion here, as described to me by Mr. Sub-Conductor Pigott, was of the same undulating character as observed throughout, but its duration was certainly not greater than one minute. Immediately on perceiving the shock, Mr. Pigott examined the sun-dial, and making a slight allowance for the error of the dial, and that for the longitude of the spot which has not been determined, the true period appears to have been very nearly 0h. 03m. 44s. P. M. Jellalabad time.

My camp was pitched about two miles North-west of Kulsea on the South bank of the Nowgong Row, (or stream,) but so feeble was the intensity of the shock, that although I was conscious of some peculiar motion at the time, it never occurred to me that it arose from an Earthquake, and it had passed from my mind till recalled by Mr. Pigott's account of what had been felt at the same time at Kulsea.

Mussoorie, in lat. 30° 30′, long. 78° 10′*, forms the most easterly limit of the Earthquake of the 19th February, in so far as my information extends. A merely incidental notice, in a Meteorological Register kept by Major Aitchison at Mussoorie, informs me of its having been experienced there. The shock, however, appears to have traversed a large portion of the Himalayan chain, since I am informed by Capt. Hutton, that it was felt at Shalkur on the borders of little Thibet, by Lieut. D. Cunningham of Engineers.

It therefore appears from the preceding details, that the tract affected by this Earthquake is, so far as determined by authentic intelligence, extended from the 69th to a little beyond the 78th meridian of East longitude, and from between the 34th and 35th to between the 28th and 29th parallels of North latitude. The superficial area thus affected, amounts to nearly 216,000 square miles, and within it are included mountain masses of great extent, varying from 2 or 3,000 to 10 and 12,000 feet in height above the level of the sea.

The general course of the shock was from East to West, parallel with that of the range of the Himalayas. Its mode of propagation appears to have been analogous to that of the waves generated when a flexible piece of metal or other substance is seized at one extremity

* The geographical positions of places in India are taken from the table of latitudes and longitudes published in Rushton's Gazetteer. They are not always strictly correct.

and shaken violently. A succession of waves flow along the course of the disturbed body, following each other rapidly until the moving force is withdrawn, and thus it appears to have been with the Earthquake under review. A series of great waves were generated on the 19th, and propagated, with an undulatory motion to a great distance, and series of smaller ones continued for upwards of a month afterwards to be continually formed, but propagated only to a very limited extent, but all in the same direction with the first mentioned.

As some remarkable instances of disturbance of the magnetism of the earth are recorded to have occurred during Earthquake shocks, it struck me that similar phenomena might possibly have been observed on the present occasion at the Simla Magnetic Observatory, and I therefore wrote to Major Boileau of Engineers, the Superintendent, on the subject, and he was kind enough to reply as follows, under date 5th November, 1842:—

"The magnetometers have been watched with great care during (*i. e.* on and after) the occurrence of Earthquakes, and there never has been any disturbance in their mean readings, though the mechanical effect has been apparent by the vibrating motion communicated to the instruments. The delicacy of our magnetic instruments is such, that a movement equal to two seconds of arc would be detected immediately, and I hold the total absence of any such indications, as almost amounting to proof, that Earthquakes are not magnetic phenomena."

If the observations at the Simla Observatory are to be held as decisive on the point, then certainly it is a just inference, that no connection exists between Earthquakes and disturbances of terrestrial magnetism; but as these observations may be opposed by numerous others indicating distinctly I think, such a connection, although the precise nature of it is yet mysterious, Major Boileau's inference must be looked upon as premature, and his observations prove, it appears to me, nothing more than, that at Simla, the Earthquakes have hitherto produced effects only mechanical, but it by no means thence follows, that Earthquakes generally are not in any respect magnetic phenomena. The question is still an obscure one, and the observations which have led to the impression that the causes of Earthquakes are counected with terrestrial magnetism have been made chiefly in districts where volcanic forces are in actual operation, and where the

causes of Earthquakes, whether of terrestrial or atmospheric origin, are in full activity, circumstances to which no analogy is presented at Simla, since I am not aware of there being in the vicinity of that place, one single proof of active volcanic agency. The question will doubtless be farther elucidated ere the labours of the various magnetic observatories are closed, but it is unnecessary to dwell longer upon it now, as it will again come under notice at a subsequent period.

The following table presents a general view of the course and phenomena of the Jellalabad Earthquake, and with it, the account of this remarkable event will be closed:—

TABLE.

Places affected.	Geographical Position. Lat.	Geographical Position. Long.	Period of Shock.	Time from point of greatest force.	Approx. Distance in degrees of Long. from point of greatest force.	Remarks.
Cabool, ..	34° 30′ 30″	69° 7′	Not specified.	..	..	Shock very severe.
Jellalabad,	34 25	70 30*	11h 40m 0°s	..	..	Point of greatest force.
Peshawur,..	34 06	71 42	11 41 12	0 1 12	1 12	Shock, very severe.
Ferozepore,	30 56 50	74 35	11 48 40	0 8 40	4 05	Shock, smart.
Delhi, ...	28 40	77 16	11 53 56	0 13 56	6 46	Ditto do.
Poojnah, ..	29 32	77 27 ?	0 00 12	0 19 12	6 57	Ditto do.
Saharanpore,..	29 57	77 32	Not specified.	..	7 02	Shock, slight.
Kulsea, ...	30 08	77 34	0 3 44	0 23 44	7 04	Shock, very slight.
Mussoorie,.	30 30	78 10	Not specified.	..	7 40	Shock, smart.

2. Earthquake of the 5th March, 1842.

On the evening of the 5th March, 1842, a very severe shock of an Earthquake was experienced at several stations in the North Western Provinces, about 9 o'clock P. M. Judging from its effects, it appears to have emanated from the interior of the Himalaya, since the stations in and near the hills were much more seriously affected than those at a distance from them. Thus the effects of the Earthquake at Mussoorie, (lat. 30° 30′, long. 78° 10′), about 7,200 feet above the level of the sea, were much more severe than at Saharanpore. In Major Aitchi-

son's Meteorological Journal, the following details of the shock are given :—

"5th March. Thermometer at sunrise 62°, wind East. Thermometer at sunset 58°, wind as in the morning, weather clear. At ten minutes past 9 P. M. a most violent shock of an Earthquake, which lasted about a minute Colonel Young's house at Deyrah was much injured, also Major Thompson's at Mussoorie, and Lord Henry Gordon's at Landour was rent from top to bottom," venetian blinds also rattled strongly, lamp glasses were violently shaken, and the oscillations causing these effects appear to have come from North to South.

The motion of the Earth from all accounts appears to have been horizontal, and the nature of the shock was wholly distinct from that of the preceding Earthquake; all who experienced both assuring me, the difference was perceptible to them at once. The effect in the present instance, instead of being like the rounded swell of a fluid or viscid mass, was sharp and sudden, like the effect of a concussion than of an undulation, and seemed indeed to be a much magnified "jarr," similar in kind to that experienced by the hand when a hammer held by it is struck on a hard unyielding body. One intelligent friend who was in his study when the shock occurred, described his sensations to be, as if he and his chair had received a sudden and severe blow from behind, and been both; impelled forward, and this appears to have been the characteristic of the shock.

The following interesting details of the Earthquake as experienced at Berkeri on the Doab Canal, were communicated to me by Sergt. and Overseer J. Petrie, to whom I feel much obliged for his trouble in preparing them:—

Letter from Sergt. J. Petrie to my address, dated 5th March, 1842.

Sir,—We had a very smart shock of an Earthquake here this evening at about 9 o'clock: so much so indeed, that every thing in this bungalow shook and rattled again. I had just laid down to rest with a book in my hand when it came on, and I started up and called out for assistance, thinking the house was coming down. Every one about the place felt it, and came running to me. I found the South door of the inner room, which I had bolted before I went to bed, had been forced open by the bolt falling down. Indeed every thing in the house

shook, and I was very much afraid of its falling, after having read the accounts from our Army near Peshawur. At that place a number of houses have been destroyed, and many lives lost from the last Earthquake.

"Although this shock did not last so long as the one of the 19th of last month, in my opinion it was much more severe for the time.

I am, &c. &c.

J. Petrie."

The rate of propagation of this shock appears to have been very rapid, as no perceptible difference in its period of arrival was observed at any of the following stations; namely, Simla and Mussoorie in the Himalayas, Deyrah in the Deyrah Dhoon, Saharanpore and Berkeri. The nature of the shock would indicate that the seat of the disturbing force must have been within the rocky crust of the earth, or at a very small distance indeed beyond it, as such a supposition accounts best for the peculiar "jarring" sensation characteristic of the shock. All who experienced the Earthquakes of the 19th of February and 5th of March, concurred in opinion, that they came from opposite directions, and as the former was from West to East, the latter must have been, as before stated, from Northto South, and this is in some measure confirmed by the fact stated in Sergt. Petrie's letter, that the Southern door of the inner room of the Berkeri canal bungalow was driven open by the shock, as it would receive the first impulse.

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3. Earthquake of the 21st of May, 1842.

The Earthquake of the 21st of May, experienced in the Lower Provinces, appears to have been only a slight shock, and its direction, in so far as this can be determined from the facts communicated, was from South-west to North-east. The most Westerly point from which I have received any intelligence of its effects is Juanpore, a station about forty miles to the North-west of Benares, the latter being in lat. 25° 30′ N., long. 83° 1′ E.

The following letter from Vincent Tregear, Esq. furnishes an account of the shock as felt at Juanpore:—

Juanpore, 29th May, 1842.

"Dear Sir,—I have to-day received the Journal of the Asiatic Society, No. 123; and as you invite communications regarding Earthquakes, I hasten to inform you, that a slight shock was felt here on the 21st inst. between the hours of 8 and 9 A. M. I did not, I regret to say, note the time, because I found that no one else in the house noticed the shock. In the evening I met Mr. Tulloh, who asked me if I had 'felt the Earthquake?' shewing that it was not mere imagination on my part. The motion seemed to be North and South. It was in reality nearly vice versâ," but without reference to some standard indicator of direction, it is impossible from mere sensations to tell the direction of a shock correctly.

"The weather," Mr. Tregear continues "here is exceedingly oppressive, and if such a state of the atmosphere can be considered as prophetic, I think we have more natural or unnatural convulsions at hand. It is more than possible that chemical or mechanical changes in the interior of the earth have great electrical influence on the surface; and these changes may be accompanied by perceptible vibrations.* * * * *

Faithfully yours,

"Vincent Tregear."

I shall have occasion in another part of this memoir to allude to some interesting atmospherical phenomena which have been found to accompany Earthquake shocks, but as this Register is intended to be simply narrative, I do not at present make any comment on Mr. Tregear's remarks.

The next place from which we have any record of this Earthquake having been felt is the city of Patna, in lat. 25° 37′ N. long. 85° 15′ E. Our information is limited to the following extract from the Calcutta *Englishman* of the 28th of May:—

"A letter from Patna," the Editor states, "mentions that a smart shock of an Earthquake was felt there at 8h. 36m. A. M. on the 21st instant."

The shock travelled next to Darjeeling, in lat. 27° 00′ N. and long. 88° 25′ E., and situated at a height of about 7,000 feet above the level of the sea. The following letter from Arch. Campbell, Esq. Superintendent of Darjeeling, gives details of the shock as experienced at that place:—

Darjeeling, June 4th, 1842.

My dear Sir,—I have seen your account of the Earthquake of the 19th of February last in the last number of the Journal of the Asiatic Society, and in compliance with your desire therein expressed to be furnished with notices of Earthquake shocks occurring in all parts of India, I have to inform you, that a slight shock was experienced at this place on the morning of Saturday, the 21st of May last, at or nearly about 10 minutes past 9 o'clock A. M. I call the shock a slight one, because it was not sensible to every person at the station, and because there was no damage done to houses or other property. It was experienced by a person in my house, although I was not aware of its occurrence. I was engaged dressing at the time, and standing, while the other person was sitting in another room reading. The sensation is thus described: "I was seated on a chair opposite to the fire when I felt a hitching motion sideways. This was repeated two or three times, and was not accompanied by any noise." The chair was placed East and West, so that the course of the shock would appear to be North and South; but whether from the South to the North, or vice versâ, the person describing it cannot say. A gentleman at the Hotel, one mile North from my house, describes the shock as having been more severe. He was also dressing at the time, and staggered into his bearer's arms, after which he had a feeling of nausea which continued for some hours. At Mr. Maddock's house, one and half mile to the South of mine, the shock is described as having been more violent than it was felt at my house, or to the North side of it.* * * * * * Your sincerely,

To R. Baird Smith, Esq. A. Campbell.

I have had frequent cause to be indebted to Dr. Campbell for details of Earthquakes experienced at Darjeeling, and I take this opportunity of acknowledging my obligations to him, not only for the assistance he has afforded me, but also for the general interest he has taken in the subject.

Correcting the time at Patna for difference of longitude, and assuming that observed at Darjeeling to be, have

	h.	m.	s.
Time of shock at Patna, ...	8	48	40
Time „ at Darjeeling,	9	10	00
Difference,	0	21	20

4. Earthquake of the 4th July, 1842.

A report of an Earthquake on the 4th July, was communicated to me by Sergt. Buttress, Overseer on the Delhi Canal, through Capt. Baker of Engineers. No other notice of this Earthquake has reached me, but Sergt. Buttress gives the details so circumstantially, that I can scarcely think he was mistaken, and the fact of his being the only one to communicate an account of it, is in no degree remarkable, since the interest in natural phenomena generally is in this country confined to a very limited circle, and numbers of these pass without any record at all. On the authority of Sergt. Buttress' letter, I therefore include this Earthquake in the Register.

Letter from Sergt. Buttress to Capt. Baker, Engineers, without date.

Sir,—As some gentleman of Engineers, whose name and address I have forgotten, has solicited information of any Earthquake that may take place, I beg leave through you, Sir, should you be acquainted with the name and address of the gentleman, to forward the following notice of one that took place at Chotah Thannah, on Monday the 4th of July, at 10 minutes to 3 o'clock P. M. by my watch, which I have since ascertained by the mid-day gun at Delhi, to be five minutes too slow, so that the time was five minutes to 3 o'clock.

It lasted about thirty seconds, and was accompanied by a rumbling noise, exactly like one of the water mills in Delhi. The motion was a violent trembling, and the direction seemed to me to be from West to East. The whole day had been dreadfully close, and scarcely a breeze blowing; but in the evening the wind rose, and has been very fresh. From yesterday up to the present moment, a dust storm has been blowing from the North-west. I have, &c. &c.,

W. Buttress, *Sergt.*
Ovr. C. D.

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5. Earthquake of the 21st July, 1842.

The Earthquake of the 21st July was experienced at Jellalabad, and the following extract from the *Agra Ukbar* of the 4th August, gives the only notice of it that has appeared. "A severe shock of an Earthquake was experienced at Jellalabad on the 21st July 1842, at a little

past 9 P. M. A reduction of temperature followed it." I am not aware whether or not this shock extended beyond the valley of Jellalabad. The perceptible reduction of temperature which followed it, is the only point of interest connected with this shock.

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6. Earthquake of the 25th July, 1842.

The immediate vicinity of Delhi alone, appears to have been affected by the shock of the 25th July. How far its effects may have extended, there are no precise data for determining, but it was evidently a merely local convulsion, and probably was felt only within fifteen or twenty miles around the city. The following Extract from the *Delhi Gazette* of the 27th July, gives an account of the phenomenon:

"A smart shock of an Earthquake, accompanied by a loud rumbling noise, woke the inhabitants of Delhi from their sleep at about a quarter to four on the morning of the 25th. It did no damage that we have heard of."

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7. Earthquake of the 7th September, 1842.

This Earthquake was experienced at Mussoorie in the Himalayas. The shock was very slight, and occurred during a severe storm at 1h. 58m. P. M. The nature of the Earth's motion was vertical, and the vibration single. The direction appeared to be from West to East, the duration of the shock was estimated at five seconds. It was not, to the best of my knowledge experienced in the Deyrah Dhoon, or any where in the Plains, as might have been anticipated from the slightness of the shock at Mussoorie.

Having been informed that at the moment of the occurrence of this Earthquake, Dr. Anderson of the Horse Artillery, had experienced sensations precisely similar to those accompanying an electric shock, I felt anxious to verify this interesting fact, and accordingly wrote to Dr. Anderson on the subject, who obligingly favoured me with the following reply:—

Letter from F. Anderson, *Esq. to my address, dated Mussoorie, 21st November,* 1842.

My dear Smith,—I certainly thought that at the time of that slight Earthquake, with the movement, that I also experienced a slight electric shock extending from the left elbow to the fingers. I was then up at "Rochville," at the very extremity (East end) of Landour. I was in the room with Mundy and two ladies, one of whom I was seated close to, she and I felt the movement distinctly, the others did not. *I alone* was conscious of the electric feeling. * * * * * *

Yours very sincerely,

F. Anderson.

Electric shocks frequently have been felt during Earthquake shocks, and it is interesting to find this phenomenon accompanying such event in India, as well as elsewhere.

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8. Earthquake of the 18th September, 1842.

The Earthquake of the 18th September was experienced at Darjeeling, and from that station only has any notice of it reached to me. The following extract from a letter from Dr. Campbell, furnishes details of the shock as experienced at Darjeeling:—

"On the morning of the 18th September, 1842, at half-past 4 o'clock, as nearly as I can determine from the comparison of watch times given by three gentlemen with the time by sun-dial and their watches on the following day, there was a smart shock of Earthquake felt at Darjeeling. Two of those gentlemen, who have given me particulars of their sensations, say, that it appeared to them to have come from the North-west and passed under them to South-east. The third says, he felt it as an "up and down" shock, and that the movement of the earth was sensible for some seconds after it was evident that the shock had passed."

Assuming the direction stated to be correct, it is not improbable that this shock emanated from the valley of Nepaul, the seat of the great Earthquake of 1833. But this of course is merely a conjecture, as evidence is wanting to warrant more.

9. Earthquake of the 26th September, 1842.

This shock was experienced at Delhi, and like that of the 25th July, appears to have been strictly local in its character. It is described as "a very smart shock of an Earthquake, accompanied by a tremendous rumbling, and lasted not less than two or three minutes." It occurred about 9 A. M., and Mr. Bingham informs me, its direction was apparently from W. to E.

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10. Earthquake of the 27th September, 1842.

The vicinity of Delhi was the seat of this Earthquake also, which was slight in its character, and came in the same direction as the preceding. Beyond the movement of the Earth, no other effects were perceptible.

The repeated local shocks to which the neighbourhood of Delhi is subject, prove distinctly, that a focus of active Earthquaking force is situated close by it. And in looking for the locality of this, I have no hesitation in fixing it in the Aravulli range of hills which skirt Delhi, and run in a South-westerly direction from it. The occurrence of the hot springs at Loweah, the disrupted state of the rocks composing the range, the occurrence of secondary trap in abundance, all shew that disturbing forces have existed, and still do exist there. I am confirmed in this opinion, by the result of Mr. Bingham's observations, who has informed me, that all the different local shocks of Earthquake experienced in Delhi, appeared to him to emanate from this range of hills. The limited extent over which the shocks are felt, shews, that the seat of the disturbing force cannot be far from the surface of the earth, while their comparatively feeble intensity proves, that the force itself cannot be of a very energetic character. I shall have occasion in a subsequent part of this memoir to shew grounds for inferring, that its effects being the standard of comparison, the disturbing force has diminished perceptibly in energy within the last few centuries. To say whether the force emanates from a central point, or whether it acts on a line of some extent is impracticable, with observations indefinite as those hitherto furnished; but if instruments for recording Earthquake shocks are ever employed in India, Delhi ought to be one of the places

selected for establishing them at, and from their indications these and other points of interest may be determined.

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11. Earthquake of the 23d of October, 1842.

This Earthquake was experienced at Gowahatty, Assam, in lat. 26° 00′ N. and long. 90° 40′ E., and at Chittagong in lat. 22° 22′ N. and long. 91° 42′ E. At the former place its effects are thus described by a correspondent of the *Friend of India:* "Oct. 23. Between 8 and 9 o'clock A. M. there was a shock of an Earthquake; the motion was tremulous, and lasted about half a minute." From Chittagong another correspondent of the same paper writes: "we had another Earthquake here; not so severe as the last on the 23d ultimo. The motion was in the opposite direction (*i. e.* from East to West) and stopped one of the above-mentioned clocks which vibrate N. and S. at 9h. 42m. A. M."

It is stated that most, if not all, of the Earthquakes experienced in Assam came from the Eastward. It is therefore probable, that a centre of active force is situated somewhere here in the Singhpho or Eastern extremity of the Naga hills, which bound the province on the East. I am too imperfectly acquainted with the localities in question to be able to say whether there are any physical or geological facts that throw light upon this idea, and it is suggested only by the uniform regularity of the direction of the shocks.

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12. Earthquake of the 25th of October, 1842.

This was experienced at Jellalabad at half-past 1 A. M. It is characterised as severe, but it appears to have been one of the local shocks so frequently felt throughout the valley in which that city stands.

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13. Earthquake of the 29th of October, 1842.

The Earthquake of the 29th of October was felt at Gowahatty, Assam, and forms an exception to the general rule as regards direction before stated, since the vibrations travelled from North to South. The correspondent of the *Friend of India*, before quoted, thus describes

the shock: "October 29th. At half past 7 P. M. a second shock occurred. The motion was from North to South, as appeared by the liquids in decanters on the dinner table. The shock was gentle, and the motion lasted about half a minute, when it was gently repeated."

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14. Earthquake of the 6th of November, 1842.

This was another of the local Delhi shocks, and was experienced at 1h. 30m. P. M., on the 6th November. Mr Bingham in communicating its occurrence to me remarks, that it makes the eighth shock experienced in Delhi during the year. Five of these are recorded in this Register, two occurred before it was commenced, and the eighth was probably that of the 5th of March, although no notice of its having been felt there has reached me. Out of these eight, six were local and primary shocks, emanating from a focal tract in the immediate vicinity of the place, while the remaining two were secondary, and transmitted from distant and distinct centres.

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15. Earthquake of the 11th of November, 1842.

The Earthquake of the 11th of November, one of the severest that had been felt for years, was confined in its influence to the Lower Provinces. Its effects at Calcutta will first be detailed, and its course then traced Eastward and Westward from that place.

I place the following Extract from a letter from H. Piddington, Esq. first among the notices of the shock at Calcutta, because it furnishes the most accurate and trust-worthy information relative to the period and direction of the shock as experienced there. The time, as given by Mr. Gray, namely 9h. 38m. P. M. will be assumed for comparison with the times at other places, and these will all be reduced to Calcutta time.

Extract from a letter from H. Piddington, *Esq. to my address, dated 24th November*, 1842.

"I learn from the watchmakers (Mr. E. Gray, the first in his profession here,) that the true time of the shock was 9h. 38m. Its direc-

tion, from the swinging of pendulums, was from about E. N. E. to W. S. W. If I hear any thing more, I shall not fail to note it for you, and I add at bottom a copy of our note made at the meeting. I was acting as Secretary for Mr. Torrens, and it did not occur to me to examine the Barometer; but I found no difference afterwards at home, and a friend who has an excellent simpiesometer assures me, that no effect was produced upon it, he having examined it immediately afterwards, so that in slight shocks the atmosphere seems to have no share.

Yours very faithfully,

H. Piddington.

The note alluded to above by Mr. Piddington, as having been made at the meeting of the Asiatic Society, is as follows: "At ——* the proceedings of the Society were interrupted by two or three slight vertical shakes or heaves of the Earth, with a noise like the rumbling of a passing carriage, and one strong horizontal shake from East to West, or from N. E. to S. W. The whole took place within about a minute of time." (Signed) H. T. Prinsep, *President.*

The following extract from a letter from J. McClelland, Esq., gives some further details of interest, and shews that the Barometer was seriously affected during the shock: "With regard to the Earthquake of the 11th November, the only information I am able to give you that has not appeared in the Calcutta papers is, that the mercury rose and fell repeatedly, to the extent of seven or eight tenths of an inch during the shocks in a Barometer on the second floor of St. Xavier's College, a house in Chowringhee. The inmates of which house also describe the water in a large pond, of about three hundred yards in length and seventy in breadth, extending lengthways North and South, to have risen into considerable waves. This was also the case with the River, which appeared agitated, as if a steamer had passed. This refers to the river at the Botanic Gardens, where it is not half so broad as it is at Calcutta. A clock in the house of the Superintendent of the Garden, which had gone regularly for years, stopped suddenly during the shock. I observed three distinct shocks, they seemed to me to be rather a tremulous motion than a waving in any one direction; but

* Time omitted as erroneous.

others observed a distinct direction of the shock; however, people are not all agreed as to what this exactly was. Probably the form of different masses of building, such as our houses in Calcutta, might occasion some little difference in the effects of the Earthquake on the sensations of different persons."

A remarkable luminous appearance of the water in the river, as observed on board the ship *Southampton*, is thus described by a correspondent of the *Englishman* of November 14th.

"Several gentlemen had just before the time been conversing upon the poop, when one pointed out the very singular luminous appearance of a portion of the river water: its Southern limit setting from N. W. towards Chaudpaul Ghaut. It was thought at first to be merely the first ebb of the tide setting down, or from the reflection of the moon, but it proved in the sequel not to be the first, and the moon was just then densely obscured by clouds, proving that also not to be the cause. On this brightness closing upon the ship, a general and severe tremor was felt throughout, as if a taut chain cable was grinding under the keel, or that a sudden squall had struck the ship. The Barometer had slightly fallen previous to this, whether from the preceding rain or caused by the Earthquake it is for others more capable to judge: I am inclined to think from the latter. From enquiries amongst several commanders, it appears, that amongst the northermost ships it was more severely felt, even to the shaking of the chain cables and cabin furniture.

"At Howrah also, we find the shock was violent in the extreme. We may therefore infer that the direction of the Earthquake must have been from N. W. to S. E."

It is stated by a correspondent of the *Englishman* of the 14th Nov., the night of the 11th was particularly close and oppressive in Calcutta. The meteorological registers kept at the Surveyor General's Office and the Honorable Company's Dispensary, present nothing remarkable farther than that rain fell on the evening of the 11th to the amount in the lower gauge of 0.14, and in the upper of 0.19 inches, none having fallen for sometime before.

The effects of the Earthquake at Serampore, about fourteen miles above Calcutta, (lat. 22° 45′ N. long. 88° 26′ E.) are described in the following extracts :—

In the *Friend of India* of the 17th Nov., it is stated in the weekly summary of events, that on the evening of the 11th Nov. at about 9h. 50m. or 9h. 45m. by the town-clock, a very severe shock of an Earthquake was experienced at Serampore. "It was accompanied by a noise which at first resembled some "mighty rushing wind," and then the loud rattling of carriages over a stony street. The shock came from the Eastward: the clocks of which the pendulums vibrated from North to South were stopped, while those which stood East and West continued going. So violent a shock has not been experienced in this part of the country for the last twenty-five years. There was an unpleasant stillness in the air previous to this occurrence, but the wind rose strongly from the Eastward almost immediately afterwards."

In the *Bengal Hurkaru* of the 14th of Nov. the following details are given: "On Friday the 11th instant, at about a quarter before 10 P. M. two severe shocks of an Earthquake were felt at Serampore. They were preceded by a rumbling noise from the N. E. towards S. W.; the undulation was very great: all the houses at the place were shaken, and those persons who had retired were obliged to jump out of their beds, and some even quitted their houses, but through the mercy of Providence, no injury was done. The Brahmans as usual were busy with their shauncks and drums. The Earthquake lasted about four or five seconds."

In the other notices of the shock at Serampore which I have received, there are no new facts, so that I do not insert them. The time stated above is, I believe, incorrect, and considerable difference of opinion exists as to the duration of the shock. Such difference always will exist, so long as mere sensation is made the measure of duration, and proper instruments alone can remedy this imperfection.

Darjeeling is situated within one minute Eastward of the meridian of Calcutta, and I therefore give next, a notice of the shock as felt there. For this I am indebted to Dr. A. Campbell.

Letter from Dr. Campbell *to my address, dated Darjeeling, 18th November*, 1842.

"On the night of Friday the 11th instant, we had a shock of an Earthquake at this place. Although not in bed or asleep at the time it occurred, I was not conscious of it. Still it was, a smart shock, accord-

ing to the accounts of those who experienced it. The ghurree at the Treasury Guard struck 10 o'clock, as the shock was felt by many persons, and one gentleman looked at his watch and found it was ten minutes past 10 P. M.—suppose, as there is no way of getting the exact time of the shock's occurrence, that it happened at 5 minutes past 10 P. M. It was so severe as to bring down pieces of plaster from the walls of "Caroline Villa" and "Mount Pleasant;" and *the* shock was succeeded soon after by a slighter one, or perhaps it was but one shock with a remission in the vibration. One person thought it came from the South and passed on to the North. I account for the shock not having been felt at my house where there was a party of seven at the time, from its being constructed of wood, which from its greater elasticity is not to be shaken to the same extent as a pile of bricks or stone.

Yours, &c. A. CAMPBELL.

The following extract from the *Englishman* of the 16th Nov. details the effects of the Earthquake as experienced at B——, a place fifty-five miles East of Calcutta.

"Arrived at B—— (fifty-five miles East of Calcutta on the Isamutta or Jaboona) at half-past 5 A. M. 12th Nov. and found Mr. —— and his family still in great alarm from the Earthquake, which they had experienced there on the previous night. Mr. —— told me that immediately his family had retired at half-past 9, his dogs and those of the neighbouring village began howling, and shortly after was a loud rumbling, similar to that of carriages going over a draw-bridge. The commencement of this was followed by a violent undulation of the ground from North to South which actually rocked the house, and ended by three or four hard shocks which threw open all the doors and windows previously shut in for the night. The house (a puckah-built upper-roomed one) cracked, and the plaister from several of the walls and ceilings was thrown down. On examining the house by daylight we found rents in several of the walls and arches of the house, and the verandah to the East separated from it. Mr. —— considered the Earthquake, from the first hearing of the rumbling noise to the last shock, to have occupied about one minute of time.

I was on the road to B —— in my palkee, in the first stage from Barraset, and did not feel the Earthquake, but I noticed at 8 P. M. to

my wife who was with me, that the weather was unusually warm, cloudy and threatening heavy rain: she called out to me about half past 9, that it thundered, and we had heavy rain on the road from half past 8 P. M. to 2 A. M.

It did not rain at B —— during the Earthquake, but it did so the preceding afternoon from 3 to 5 o'clock, and the weather all day had been sultry; the same was experienced in Calcutta.

Mr. ——'s Pundit arrived at B —— at 10 A. M. on Saturday the 12th. He was in a boat in the Soonderbuns, and stated that the waters were much agitated, and his boat was tossed about as if by waves in a squall of wind."

The Editor of the *Englishman* appends to the above the following note :—

"We learn from another quarter, that the shock of the Earthquake was severely felt on board the *Agincourt*, about fifty miles South-east of the Floating Light at 9h. 30m. A. M."

At Acra on the bank of the Hooghly, about five or six miles below Calcutta, the shock seems to have been very severe. The house of Mr. Greenfield there is represented as having been rent from top to bottom in twenty different places. He states, "it was so severe that the doors rattled so that you could not hear yourself speak, and the mortar from one end of the house to the other was flying down in handfulls. We had four shocks, three first and one about a quarter of an hour afterwards: empty bottles were broken at the mill, and the pigs and fowls, ducks, geese, dogs and horses made a most hideous noise. A little more and all would have been down, as the beams began to start."

At Pubnah (lat. 24° 32′ N. long. 89° 12′ E.) the shock was experienced at 9h. 47m. Calcutta time. Another slight shock occurred at 10h. 30m. C. T. The direction here was from S. W. Two indigo boiler chimneys and that of a rum distillery were thrown down, and the banks of the river in front of the distillery are said to have been fissured. The correspondent of the *Englishman*, however, who gives these details of the effects of the shock, is so remarkably facetious, that suspicions of exaggeration are excited.

At Barrisaul (lat. 22° 45′ N. long 90° 11′ E.) the shock appears to have been felt at very nearly the same time as at Calcutta, the period being 9h. 38m. 12s. C. T.

The following letter published in the *Bengal Hurkaru*, gives an account of the Earthquake as experienced at Barrisaul :—

" As I dare say that the shock of Earthquake which was felt here will have been likewise experienced at other stations with more or less severity, accounts of which will doubtless be communicated to you, I lose no time in telling you now, that a very severe shock was felt at a quarter to 10 P. M. at this station yesterday (Nov. 11th); although no accident occurred, considerable anxiety was caused by the length of time the Earthquake lasted. The heaving of the ground appeared to travel from E. to W. and continued with violence for about one minute. The river was greatly agitated, so much so, that the serangs of several pinnaces came on shore, unable to account for the extraordinary motion of the water.

" I send down this account, because I imagine that an Earthquake of such severity having been felt at a place where its occurrence is so unusual must have extended elsewhere, and all information on the subject may prove interesting.

" P.S.—The weather for the last few days has been remarkably warm for the season of the year; the variation in the Barometer has not been great. The Earthquake was accompanied by a rumbling noise, similar to that caused by heavy ordnance passing over the ground."

At Gowahatti, Assam, (lat. 26° 00′, long. 90° 40′ E.) the shock was felt very slightly. Its period there was 10h. 00m. 56s. C. T. A correspondent of the *Friend of India* describes the motion as merely tremulous, but sufficient to attract the attention of four persons who were seated together at the time.

The shock was felt more severely at Chittagong, (lat. 22° 22′ N. long. 91° 42′ E.) probably because it had to traverse only alluvial lands, and had no mountainous tracts, as in Assam, to decrease its force. The period as given by two tolerably correct clocks, was 9h. 42m. 48s. C. T. The direction of the oscillation was from North to South, as determined by the motion of hanging lamps, &c.

The only place at any distance to the westward of Calcutta, whence any notice of the shock having been felt has reached me, was Monghyr (lat. 25° 02′ N. long. 86° 29′ E.) where a portion of the fort wall is said to have been brought down. No farther particulars have come under my observation, and I am unable to state either the time or direc-

tion of the shock at that place. At Baughulpore (lat. 25° 13′ N. long. 86° 58′ E.) I am informed by Mr. Piddington, that the shock was *not* felt.

It therefore appears that, *in so far as the facts collected extend*, the tract affected by the Earthquake of the 11th November 1842, was bounded on the North by Darjeeling, on the East by Chittagong, on the West by Monghyr, and on the South by the position of the ship *Agincourt*, thus including about five degrees of longitude and five of latitude. That to the Eastward and Southward, and probably to the Northward also, the shock extended beyond the limit here assigned, can scarcely be doubted, from its intensity at the places specified as the bounding points of the tract in these directions, but there is no information available to prove that it did do so, and I am unwilling to venture upon conjecture.

It will have been observed, that at different places the shock appeared to travel in every different direction. Thus:—

At Calcutta,	the direction was	from E. N. E. to W. S. W.
At Pubna,	,,	from S. W. to N. E.
At Darjeeling	,,	from S. to N.
At Chittagong	,,	from N. to S.

Now, it appears to me, that the only way in which these statements can be connected and rendered consistent, is to conceive the undulations of which the shock was composed, to have been propagated in a manner analogous to waves formed in water when a stone is thrown into it. Proceeding thus in all directions from a central point, the undulations would seem to observe to come from different directions, dependent on their position, relative to the centre whence the undulations had emanated. Of course waves propagated through the crust of the earth could retain but little of that perfect symmetry characteristic of waves in a homogenous fluid like water, since their forms would necessarily be modified by the variable nature of the strata through which they were being transmitted, and hence departures from strict theoretical accuracy of direction are to be anticipated. Assigning therefore a certain degree of *circularity* to the undulations of the Earthquake of the 11th Nov. and conceiving the centre of emanation to have been some little distance to the N. E. of Calcutta, it will be found that the observations on direction become to some

extent, consistent. At Calcutta the course would appear to be from N. E. to S. W.; at Pubna from S. E. to N. W. instead of from S. W., as stated before; at Darjeeling from South to North; and at Chittagong from the opposite direction. Some of the observations made, as at Barrisaul, do not correspond strictly with this view, but many sources of error exist when sensations are taken as the only guides, and by these it is possible the observations may have been affected. The idea of the circular propagation of the undulations is suggested only as a method of connecting the facts, and farther than it does so, I have no wish to claim any authority for it, the observations on which it is founded being too indefinite generally, to warrant this being done.

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16. Earthquake at Baroda, 1842.

I regret that I have been unable to ascertain more regarding this Earthquake than that it occurred during the year 1842. I am therefore able only to record it, a circumstance I regret the more, as Baroda lies in the usual track of the Earthquakes of the Delta of the Indus, and it would have been interesting to ascertain, whether this shock had emanated from that focus, or was independent of it.

The Register is now completed, and I defer all comment upon the phenomena of the Earthquakes recorded in it, until the completion of the second part of this Memoir, when the phenomena of Indian Earthquakes generally, will be analysed.

Remarks on some of the disturbing causes in Barometric Observations. By Captain Shortrede, *First Assistant, G. T. Survey.*

If the barometric oscillations were perfectly uniform in different situations, it would obviously be a matter of indifference, theoretically, at what times of the day the observations might be made, provided they were simultaneous. But it is well known to those who have examined the subject, that the oscillations though tolerably uniform in low latitudes, are subject to particular variations, the causes of which are often not easily assigned. Whatever these causes may be, it is by no means likely that their effect will be transmitted in-

stantaneously through a long column of air, and hence it appears desirable, that the comparative observations should be made about the times of maximum and minimum of the atmospheric tide, when, the variations for a considerable time being almost insensible, it may be supposed that the causes will act with least disturbance. Another practical reason for selecting the times of maximum and minimum is, that perfect simultaneousness being seldom to be expected, it is evidently of advantage to select for observation those times at which the want of this condition will produce the least effect. About the middle of the tide, the barometer generally will vary as much in the course of five minutes, as it will in half an hour from the time of maximum or minimum.

Though these remarks seem true as far as they go, yet in particular cases, the atmospheric tides may be so affected by circumstances of locality, as to present anomalous results. I am unable at present to quote the documents containing the observations which gave occasion to what I am now about to state, but the results were so uniformly and repeatedly observed, that beyond settling the precise numerical amount of discrepancy, the possession of the original observations would add little to the evidence.

When I was in charge of the Bombay Trigonometrical Survey, I made many barometric observations in the Dekhan and along the Sea Coast. These were compared sometimes with those made at the Engineer Institution in Bombay; sometimes with the observations made by Colonel (then Major) Sykes at Puna; and sometimes with those of a barometer left in Puna for the purpose. All the observations on the Sea Coast compared with those made inland from the face of the Ghats, as at Puna agreed in one result, but I shall confine myself more particularly to the results of a special comparison for determining the height of Puna above the Sea.

One of my barometers had been repeatedly boiled, I believe upwards of twenty times, and it was so perfectly free from air, that when set up, the mercury used to adhere to the top of the tube six inches above the level at which it stood when shaken. The tube was full 32 inches long, and the mercury adhered to the top at a station upwards of 4000 feet above the Sea, where the proper height of the mercury was about 25.05m. This barometer was compared for several

days with one of Major Sykes' barometers, which I had filled and boiled, in which also the mercury used to adhere to the top of the tube. These two barometers used always to stand at the same height within a thousandth of an inch about the middle of the tide, but at the times of maximum and minimum, one of them used to range about two-thousands above and below the other. The difference to maximum and minimum being never less than ·001, nor more than ·003. We considered them to be the most perfectly comparable of any two barometers we had ever seen. Major Sykes' barometer remained on the spot where the comparisons had been made, while mine was carried to Bombay, and as the mercury still continued to adhere to the top of the tube, it plainly had not been deteriorated by the journey. Our observations were made simultaneously at 10 A. M. and 4 P. M. for several days successively, but on calculating them, I found that the 10 o'clock observations always gave the height of Puṇa about 100 feet more than was given by the 4 o'clock observations. I ascertained beyond doubt, that there had been no mistake of a tenth of an inch in registering the observed heights. The like discrepancy continued at several other stations along the Sea Coast. This discordance of result being unvaried, naturally set me to consider what might be its probable cause: and the only cause I have ever been able to discover at all likely to account for the fact, is in the effect of the Sea breeze, which at that season of the year begins to blow about 8 or 9 A. M. along the coast, while towards Puna it is not felt till about 2 P. M. After blowing over the low lands in the Konkan, it is intercepted about midway by the Seihadri Ghats, which presenting an almost perpendicular scarp of from 2000 to 3000 feet, cause the air to accumulate over the low land, thereby increasing its barometric pressure to an amount equivalent apparently to about a tenth of an inch of mercury, corresponding to a column of about 100 feet of air, somewhat similar to the *head of water* produced by an obstacle placed in its current.

I am aware that some persons may be disposed to treat this statement as of little authority, for want of the actual observations on which it is founded. The fact, however, is tangible, and may be submitted to proof or disproof by any one who chuses to make the necessary observations.

The purpose for which I have made the statement, is to call attention to the influence of locality as affecting the results of barometric measurements. Different places may have particular times, at which it is unsafe to trust to barometric observations for correct results.

As there seems reason to suppose, that the principal deranging causes in barometric measurements are connected with the sun and wind, I have often thought that probably the results by night observation may be found to be more consistent than those by day observations. Unless experience should shew a more favorable time, I should prefer observations made about the time of the morning minimum of the tide, because so far as I have observed, the air is then more generally calm than at any other time. This, however, is a matter of fact, on which every one may judge for himself according to his means of knowledge.

I have been led to the same conclusion by endeavouring to trace the causes of the atmospheric tides, which I am disposed to refer entirely to the direct or remote action of the sun. The following is offered as an attempt to trace this action, and though perhaps not altogether satisfactory, it may lead to something better.

When the sun rises over China, the atmosphere there getting heated, expands and begins to flow off towards the west, where the sun is exerting no heating power. As the solar heat increases, the western efflux of atmospheric air increases, and goes on increasing till the sun is past the meridian. When the sun rises over India, a similar western efflux is occasioned, but for some considerable time the influx from the eastward being greater than the efflux towards the west, the atmospheric pressure goes on increasing, till by and by, the direct heating effect over India causes a western efflux at first equal to, and then greater than, the influx from the eastward. The atmospheric pressure thenceforward decreases, and it goes on to decrease so long as the heating power of the sun causes the air to expand. At the surface of the earth, this effect is greatest about 2 or 3 P. M., but it is not till the heated atmosphere has had time to ascend and dislodge colder air that the total effect is greatest. The atmospheric pressure is then a minimum. When the sun is exerting its greatest power over India, it has ceased to heat the countries to the eastward: the air over these countries being colder, presses on that over the countries to the west-

ward, which is specifically lighter, until the air here being similarly cooled in like manner, proceeds to press on and displace the warmer air to the westward. When the influx balances the efflux, there is the evening maximum: after which the accumulated air gradually disperses itself till towards morning, when it is again pressed on before sunrise by the air heated in the east.

If this be a true account of the atmospheric tides, it is plain, that supposing the air to be calm, we may expect the disturbing causes will be least about the time of the morning minimum; and that at any time during the night if the air be calm, these are likely to be much less influential than during the day, for then they are entirely free from the direct action of the sun, which evidently has a great effect on barometric heights by the inequalities of temperatures which it occasions in different places. We know that even in the hottest weather, the temperature on the Sea Coast is tolerably uniform when compared with that of places inland, particularly when these inland places are on elevated plains. In such cases we cannot safely assume that the mean of the temperatures at the two stations will truly represent that of the intermediate column of air: or perhaps, to speak more properly, it cannot be assumed that the temperature and moisture at the upper station will approximate to those of a place on the same level immediately over the lower station; besides which, the barometric pressure at the inland station may be very different from that at the supposed station on the same level if, as is most likely, the state of the wind should be different in the two places. In short, any thing analogous to wind or current which would affect the correctness of water-levelling may be expected in a still greater degree to affect the correctness of barometric-levelling: and we may infer as a general conclusion that, besides the goodness of the instruments employed, the trustworthiness of barometric measurements will greatly depend on the care and skill with which the observers avoid the influence of disturbing causes.

11*th April*, 1842.

On Barometric Heights. By Captain R. SHORTREDE, *First Assistant Grand Trigonometrical Survey.*

If I remember rightly, your correspondent D has given a formula for computing Barometric heights, which to me appears to be neither so simple nor easy of recollection as that given by Professor Leslie, at the end of his Geometry; which is "As the sum of the mercurial columns is to their difference, so is the constant number 52,000 to the approximate height" in feet. This rule is easily remembered, and is not far from the truth; but a more correct result may be obtained by using 52,200 as the 3rd term. At the height of a mile the height thus found differs only nine feet in defect from that obtained by a logarithmic calculation, whereas by Leslie's rule the defect is twenty-nine feet. When the height does not exceed 4,000 feet, 52,200 gives within two feet of the logarithmic calculation. At elevations above a mile, the difference increases rapidly: it then becomes necessary, as Leslie recommends, to subdivide the interval into smaller portions.

The following Table shews the results of the several Rules.

Barometers.	Approximate Height by Logarithms.	52,200.	52,000.
30 and 29.5	438.0	438.7	437.0
... „ 29.0	883.4	884.7	881.3
... „ 28.5	1336.6	1338.0	1333.3
... „ 28.0	1798.0	1800.0	1793.1
... „ 27.5	2267.3	2269.1	2260.4
... „ 27.0	2745.4	2747.4	2736.8
... „ 26.5	3232.5	3233.6	3221.2
... „ 26.0	3728.9	3728.6	3714.3
... „ 25.5	4234.9	4232.4	4216.2
... „ 25.0	4750.9	4745.5	4727.3
... „ 24.0	5814.6	5800.0	5777.8
... „ 23.0	6923.6	6894.3	6867.9
... „ 22.0	8081.9	8030.8	8000.0
... „ 21.0	9294.1	9211.8	9176.5
... „ 20.0	10565.5	10440.0	10400.0

At 3700 feet by using 52,200 we get exactly the same result as by logarithms.

Leslie's rule is then in defect about 15 feet.

This rule may be thus expressed in words: "The sum of the barometric columns at the two stations is to their difference, as 52,200 to the approximate height in feet," and algebraically (B and b being the barometers at the 2 stations)

$\left(\frac{B-b}{B+b}\right)$ 52200 = Approximate height (A).

On the reduction of mean temperature by elevation, Professor Leslie has given the following formula as the result of his experiments on the cold produced by diminution of barometric pressure. If B and b denote the barometric pressure at the lower and upper stations; then will $\left(\frac{B}{b}-\frac{b}{B}\right)25$ express on the Centigrade scale, the diminution of heat in ascent (B). This formula cannot be universally true, though it is known to give results agreeing very well with observation in moderate elevations. For if we suppose three stations A, B, C, in the same vertical line at which the barometer stands respectively at 30, 20, and 10 inches, it is obvious that the reduction of temperature between A and B together with that between B and C must be the same as the whole reduction from A to C. The formula gives $\left(\frac{30}{20}-\frac{20}{30}\right)25=20.83$ as the diminution from A to B; and $\left(\frac{20}{10}-\frac{10}{20}\right)25=37.5$ as that from B to C: the sum of which is 58.33. But we have also $\left(\frac{30}{10}-\frac{10}{30}\right)25=66.67$ as the reduction from A to C. This differs so much from the former result, that we may without any hesitation conclude that the formula cannot be strictly true. In order that the diminution from A to C may be equal to the sum of the diminutions from A to B and from B to C, it seems necessary to make it proportional to the ratio of the densities, or as the logarithm of $\frac{B}{b}$; that is, as the difference of the logarithms of the barometers at the two stations; and if we assume that Leslie's formula gives results not sensibly differing from the truth, at first, we shall have 115 log. $\frac{B}{b}$ to be marked (C) as the expression for the diminution of temperature on the Centigrade scale, or 207 log. $\frac{B}{b}$ to be marked (D) on Fahrenheit, which will give *consistent* results in all cases.* The diminution of temperature is thus proportional to the approximate height in barometric calculations, and if we calculate the approximate height corresponding to a reduction of 1 degree in temperature, we shall have 521.738 feet for 1° cent. and 289.86 feet for 1° Fahr., or in round numbers 522 for 1° cent. and 290 for 1° Fahr. at the temperature of freezing. The numbers 522 and 290 will require a correction for mean temperature, as in barometric measurements: This may be done very simply. The expansion on a column of air of 522 feet for 1° cent. is just about 2 feet, and on 290 feet for 1° Fahr. the expansion is 6 feet very nearly. Hence the corrected numbers may be found

* If necessary the co-efficient may by corrected so as to agree with observation.

as follows: To 522 add twice the number expressing the mean temperature in degrees cent., and we have the correct height corresponding to a difference of 1° cent. and on Fahr. multiply the mean temperature above 32 by 0.6 and add it to 290, the sum is the correct height giving a difference of 1° Fahr.

The following Table may be convenient for reference.

Mean Temp. Cent.	Height for 1°.	Mean Temp. Fahr.	Height for 1°.
0	522	30	289
5	532	32	290
10	542	40	295
15	552	50	301
20	562	60	307
25	572	70	313
30	582	80	319

I may perhaps have occasion to refer again to this subject.

There is a formula for finding the approximate height in barometric operations of the same general form as that of Leslie, for diminution of temperature. The formula is $\left(\frac{B}{b}-\frac{b}{B}\right)$ 13050=Approx. Ht.* (E) The co-efficient in this formula is half the height of the equiponderant column. The co-efficient of formula (A) before given is 52,200, being *double* the height of the equiponderant column, or just 4 times the co-efficient of formula (E). Now as in Leslie's formula the co-efficient is 25 cent. or just $\frac{1}{4}$ of the interval from freezing to boiling, we may therefore transform it into another of the form (A) and it becomes $\left(\frac{B-b}{B+b}\right)$ 100=diminution in degrees cent. or $\left(\frac{B-b}{B+b}\right)$ 180= diminution in deg. Fahr. which may be thus expressed: "The sum of the barometers at the two stations is to their differences, as the No. of degrees in the interval from boiling to freezing is to the diminution of mean temperature by ascent." This rule will give results not sensibly differing from those of the logarithmic formula (C and D) at intervals of 4000 feet, or even at a mile.

* The formula, $\left(\frac{B}{b}-\frac{b}{B}\right)$ 13,000 and $\left(\frac{B-b}{B+b}\right)$52,200, for the approximate height, are only close approximations to the truth, and are not absolutely identical: the former errs in excess, and the latter a little in defect. If they were absolutely identical, we should have $\frac{B}{b}-\frac{b}{B}=4\,\frac{B-b}{B+b}$, or $\frac{B-b}{B+b}=\frac{B^2-b^2}{4Bb}\,\frac{(B+b)(B-b)}{4Bb}$, from which by transposition and division we get 4 B b=,B+b,^{2}=B^2+2Bb+b^2 hence 2 Bb=B^2+b^2, which however do not differ much from the truth when B and b are nearly equal.

Catalogue of Nepâlese Birds presented to the Asiatic Society, duly named and classified by the Donor, Mr. Hodgson, [*and revised by the Society's Curator*].*

1. [*Spizaëtus* (Vieillot, as recognised by Messrs. Jardine and Selby, *Ill. Orn.* pl. LXVI) *grandis*:†] *Nisaëtus grandis*, Hodgson, [*J. A. S.* V, 230;] (aberrant species:) [*Nisaëtus niveus* ? Jerdon, 'Madras Journal,' No. XXIV, 69,‡ (as identified from a specimen presented to the Society by that gentleman;) but not *Falco niveus*, Temminck, which is *Nisaëtus Nipalensis*, Hodgson, *J. A. S.* V, 229, and apparently also the *F. caligatus*, Raffles, *Lin. Trans.* XIII, 278, wherein the statement that it measures "more than three feet across the wings" would seem to be a misprint for five feet: the latter species, *i. e. niveus* (aut potiús *caligatus?*) is not uncommon in Lower Bengal, adults having the under-parts very handsomely streaked with deep brown or brownish-black, of which but slight or sometimes no traces occur in the young; one adult female which I have obtained, that was paired with a mate of the ordinary colour, being wholly dusky-black, with an ashy tinge on the upper-parts; its brilliant golden irides contrasting finely with the blackish hue of the plumage.

The *Sp. grandis* varies much in colouring according to age, and somewhat even at the same age; wherefore, as Mr. Hodgson's des-

* *Vide* XI, 778.—It was the wish of Mr. Hodgson that this Catalogue should have been published immediately, but this could only have been done in a very crude and imperfect manner, and the delay is more than compensated by the suppression of a host of unpublished synonyms, which would otherwise have required to be subsequently reduced. I have also had to find up the various scattered descriptions by Mr. Hodgson, and to collate the synonymy of many of the species, besides drawing up descriptions of several new species, — altogether no inconsiderable labour. Moreover, the delay has enabled Mr. Hodgson to improve the nomenclature considerably, both as regards the institution of some necessary new genera, and the specific appellations of certain of the new species.—E. B.

† Since writing the above, I have strongly inclined to the opinion that this is the *Aquila Bonelli*, of which I have no good description to refer to. *A. Bonelli* is included in Mr. Vigue's list of birds procured in Kashmir and little Tibet, *P. Z. S.* 1841, p. 6, the present species, besides being quite crestless, has the cere of an *Aquila*, and not of a *Spizaëtus;* but its irides are bright yellow, as in the latter group, and the general form also inclines more to the latter.

‡ *Vide* also Elliot, in No. XXV, p. 234, of the same publication.

cription of this fine species was drawn up from a single specimen, being the only one that he had then obtained, it is quite necessary to describe it anew, in its different phases.

Length of an adult male twenty-seven inches, by sixty inches in spread of wing (Hodgson); of a female, eighteen inches (Elliot). The closed wing, in a series of seven specimens before me, varies from seventeen inches and a half to twenty inches and a quarter, and the tail from eleven inches to twelve inches and a half; but the greater number approach to the respective former of these dimensions: from point of upper mandible to gape measures about two inches, more or less; tarse about three inches and a half: the talons large and formidable.

This bird approaches somewhat in form to the true *Aquilæ*, and is distinguished from its congeners by the absence of all trace of the usual occipital crest. Adults deep aquiline-brown above, the somewhat lanceolated feathers about the nape laterally margined with whitish, or, in some, with pale brown: tail more or less greyish, and crossed with about seven narrow dark bars, in addition to the subterminal one which varies much in breadth: under-parts pure white, with a narrow dark brown mesial streak to each feather; the tibial plumes chiefly deep brown, freckled with whitish; and the under-coverts of the wings dark brown. Bill plumbeous, its tip and the talons black; cere and toes pale waxy-yellow; irides bright yellow. The mesial stripes on the feathers of the under-parts incline to be broader in the female, and are more developed on the belly, where in some the dark brown colour predominates, spreading in bars over the feathers; under tail-coverts also more or less distinctly banded: some specimens shew the white bases of the feathers very conspicuously about the nape: the inner webs of the tail-feathers are prettily mottled, more especially in adults, as also those of the primaries anterior to their emargination; underneath, the tail is albescent, and its bars are more or less obliterated, with the exception of the terminal one when broad. The young have the lower parts deeply stained with ferruginous (more or less so), and the mesial stripes to the feathers narrow and inconspicuous, scarcely occupying more than their shafts; tibial plumes the same, though in some there are traces of the marking on those of the adult; and the fore-part of the under-surface of the

wing is also similar, or nearly so, having at most a dark patch on the under-coverts of the primaries: above, the general cast of colour is merely paler than in the adult, the deeper hue of the latter being confined to near the tip of each feather and along the shaft, whereas in adults it spreads nearly to the edge: and the tail appears more closely barred, with blackish or deep brown upon a pale ground-hue.

The Crestless Eagle-hawk (as this species may be appropriately termed) appears to be generally, though sparingly, diffused over the wooded districts of the mountainous parts of India, while on the Himalaya it would seem to be not unfrequent. It hunts more on the wing than its congeners, in conformity with its structural approximation to the true Eagles. Mr. Jerdon observes, that it is certainly a rare bird in Southern India; and Mr. Elliot, that it "is the noblest of the Indian Eagles, being seldom seen, and then generally at a great height in the air, in wild and savage places. It preys on the Hare — I once saw a pair of them hunting in company, which nearly surprised a Peacock, pouncing on him on the ground." This gentleman remarked its distinctness from the *Falco niveus* of Temminck, to which Mr. Jerdon dubiously referred it. The latter does not hitherto appear to have been met with in Southern India, though tolerably common in Bengal, and also in Nepâl.

2. [*Hæmatornis undulatus*, Vigors, *P. Z. S.* 1831, p. 170; Gould's *Century*, pl. I.] *Circäetus Nipalensis*, Hodgson [*As. Res.* XVIII, pt. II, p. 17 (published 1833)], this bird being clearly a *Circaëtus*. [*Falco bido (?)*, Horsfield, *Lin. Trans.* XIII, 137 (1821!): *Buteo bacha (?)*, apud Franklin, *P. Z. S.* 1831, p. 114; and *Hæmatornis bacha (?)*, Sykes, *Ibid.* 1832, p. 79. When this species was characterized by Mr. Vigors, "the three species of the group (*Hæmatornis*, Vigors,) were exhibited; their general similarity in colour and markings pointed out; and their specific differences explained. These consist chiefly in size; the *H. holospilus*" (*P. Z. S.* 1831, p. 96, from Manilla,) "being one third smaller than" (the African) "*H. bacha;* while *H. undulatus* considerably exceeds the latter. The first is spotted all over the body, the second only on the abdomen; while the third is marked by spots on the wing-coverts, and by *ocelli* bearing an undulated appearance on the abdomen, the breast also being crossed by

undulating *fasciæ*." A common species in Bengal, as in India generally.]

3. *Pandion* [*haliaëtus:* diffused in suitable situations throughout India.

4. *Icthyaëtus Horsfieldi: Falco icthyaëtus*, Horsfield:] *Haliaëtus plumbeus*, Hodgson [mentioned in *J. A. S.* VI, 367. Not uncommon in Bengal. The spotted first plumage of this bird much resembles the corresponding garb of the common Indian Kite *(Milvus cheela)*; and in its next dress the basal portion of the tail is brown, more or less barred above.

A second species presenting the same characters is the *I. nanus*, Nobis, *J. A. S.* XI, 202. It is distinguished by its very inferior size, the closed wing measuring but fourteen inches in length. The only specimen I have seen was received from Singapore, being clad in worn nestling plumage, whereof the terminal pale spots had almost disappeared; and there is a considerable admixture of white on the new feathers growing on the under-parts, forming central streaks on the plumage of the abdomen. The fully adult garb would probably much resemble that of the preceding species. It appears to me that the term *Icthyaëtus* should be restricted to these birds with smooth talons, like those of an Osprey; and that the *Icthyaëtus leucogaster* of Gould's magnificent 'Birds of Australia' (the *Falco leucogaster*, Latham), which scarcely, if at all, differs from the Indian *Haliaëtus blagrus* except in its much superior size, should be retained in *Haliaëtus*, wherein Mr. Gould had already classed the young as *H. sphenurus P. Z. S.* 1837, p. 138), as I formerly arranged a specimen of *H. blagrus* (in second plumage), by the appellation *Icthyaëtus cultrunguis*, *J. A. S.* XI, 110.

The truth is, that after *Haliaëtus* has been dismembered by the detachment of *Icthyaëtus*, Lafresnoy, there still remain three marked natural divisions of the genus, which are as follow:—

A. The typical form, as exemplified by the European *albicilla* and North American *leucocephalus*, and to which the Indian *H. Macei* and some others likewise appertain. This last mentioned bird is the *H. albipes*, Hodgson, *J. A. S.* V, 228; and the young in first plumage is the *H. lineatus*, Gray, and in second plumage the *H. unicolor*, Gray, of Hardwicke's Illustrations.

B. The wedge-tailed group, exemplified by *H. leucogaster* and *H. blagrus;* referred by Gould and since by myself to *Icthyaëtus*, but, as I now think, erroneously.

C. The diminutive group with comparatively feeble talons, exemplified by *H. Pondicerianus* (the *Brahminee Cheele* or *Sunkur Cheele* of India), and the Australian *H. leucosternus*, Gould, *P. Z. S.* 1837, p. 138. To this division Mr. Gould has since applied the term *Haliastur*.

Ornithologists in this country should seek to obtain the *Icthyaëtus nanus*, which most probably will be found to occur.

5. *Spizaëtus pulcher;*] *Nisaëtus pulcher*, Hodgson, [mentioned in *J. A. S.* VI, 361, and now regarded by him as typical of that group. It devolves on me to furnish a description of this showy species, which may readily be distinguished from its congeners by its longer and handsomely banded tail, whereon are five dark bars, as broad as or broader than the interspaces of pale ground-tint, whereas in the other species the dark caudal bars are much narrower than the intervening spaces. The occipital crest is fully developed, measuring four inches in length. Plumage of the upper-parts deep aquiline-brown, very dark on the interscapularies, and verging upon black on the crown and occipital crest, which is slightly tipped with whitish; nuchal feathers conspicuously margined with tawny-brown, and their pale basal colour more or less shewing about the nape: under-parts whitish, more or less deeply tinged with fulvous, and marked on the breast with longitudinal broad mesial dark streaks to the feathers; the chin is blackish, continued as a median line to the breast, and two similar lateral streaks, at first very broad, proceed from the corners of the gape; belly and flanks more or less distinctly banded with brown and white, the latter narrower, and the brown darker towards the white, — the belly especially having a confusedly mottled appearance, and the under tail-coverts are similar; the lengthened tibial plumes are more distinctly banded, and the tarsal less so, becoming whitish towards the toes: tail as described, having five broad dark bands, with interspaces of a mottled light brown, becoming greyish with age; its larger upper coverts also banded brown and white, the latter narrower: primaries and secondaries dark brown, banded with blackish; their under surface and that of the tail albescent, with the bars anterior to the emargination of the primaries, and those of the outermost tail-feathers, semi-obsolete.

Length twenty-nine to above thirty-two inches, of which the tail measures thirteen to fourteen inches and a half; wing eighteen to nineteen inches; tarse four inches and a half, and in one specimen before me very densely feathered, in another much less densely. Bill two inches from point to gape, in a straight line: the talons large and powerful. Both these specimens are evidently adults, and probably male and female.

Three Indian species of this group have now been noticed; viz. *grandis*, *niveus* (aut *caligatus ?)*, and *pulcher;* and there remain the following: *Sp. cristatellus* (Tem.), Jardine and Selby. *Ill. Orn.* pl. LXVI; Elliot, in *Madras Jl.*, No. XXV, 234; ——*Sp. Kienerii; Astur Kienerii, Magasin de Zoologie*, Guérin, 1837, pl. 35; *Sp. albogularis*, Tickell (Nobis), *J. A. S.* XI, 456, —— *pallidus*, mentioned only by Mr. Hodgson in *J. A. S.* VI, 361, which I do not know; — and *rufitinctus*, McClelland and Horsfield, *P. Z. S.* 1839, p. 153, which would scarcely seem to belong strictly to this genus.*]

6. *Limnaëtus* [*unicolor*, Vigors; *Falco limnaëtus*, Horsfield; *F. unicolor*, Temminck; *Morphnus hastatus (?)*, Lesson, *Zoologie du*

* Since the above was written, the Society has received two fine specimens of a member of this genus, which, from Mr. Elliot's description, I am disposed to refer to *Sp. cristatellus*. Length about twenty-six inches, of wing from bend sixteen inches, and tail twelve inches; bill, from point to gape, an inch and three-quarters; and tarse four inches and a half anteriorly: occipital crest four inches. Colour of the upper-parts light fulvescent-brown towards the edges of the feathers, their central portion dark aquiline brown, which latter is confined to a mesial streak on the feathers of the nape; prolonged occipital crest dull black: under-parts white at base, and for the greater portion of each feather, their terminal part having a mesial dusky streak, edged with light brown; a dusky streak more or less developed from each corner of the lower mandible, and a central one on the throat well developed in one specimen, indistinctly so on the other; a brownish bar across the abdomen more or less distinct; and posterior to this the abdominal feathers and lower tail-coverts are banded with light fulvous-brown, and broadly tipped with the same, the tibial and short tarsal plumes being similarly coloured: volar feathers of the wings dusky externally, their inner webs brown with dusky bars, and the pale portion passing into white internally, anterior to the emargination of the primaries; underneath the volar plumes are white anterior to their emargination, and barred with dusky beyond it; the fore-part of the under surface of the wing being also white, mottled with dusky-brown, and the axillaries and sides marked with rufescent-brown: tail also brown above, with five dusky bands on the older specimen, the basal one indistinct, and the last or subterminal band broadest; in the other marked with six dark bands, and the rudiment of a seventh at base; underneath albescent, the dark bands partially obsolete. This species is not improbably Mr. Hodgson's *pallidus;* and can only doubtfully, I think, be referred to that figured by Messrs. Jardine and Selby.

Voyage de M. Bélanger, p. 217. A second species of this division exists in the *L.* (olim *Buteo*) *punctatus*, Jerdon, *Supplement.*]

7. *Falco* [*shaheen*, Jerdon, *Madr. Jl.* No. XXIV, 81.]

8. *Pernis* [*Ellioti*, apud Jerdon, to whom the specimens were transmitted for examination. I must confess, however, that I am by no means satisfied of the distinctions pointed out between this and the *P. cristata*, Cuvier, vel *Falco ptilorhynchus*, Tem.; specimens of both being before me so labelled by Mr. Jerdon; and one of the latter minutely agrees with the description of *P. maculosa*, Lesson, in the *Zoologie du Voyage de M. Bélanger*, except in possessing a distinct crest. Now I am unaware that any good distinction has hitherto been remarked between the *P. cristata* and *P. apivora*, further than that the European bird is never crested, both being alike variable in plumage; and I see that the latter is enumerated among Dr. Royle's birds procured at Saharunpore. In reference to the value of the character derivable from the presence of a crest, it may be remarked that Mr. Hodgson describes a variety of *Spizaëtus niveus* (his *Nisaëtus Nipalensis*, *J. A. S.* V, 229), having "a drooping Egret-like crest of two long, narrow, composed plumes"; whereas in general, and in all cases observed by me, this species has merely a very slight indication of such a crest at any age. Nevertheless, the prevalence of the crest in Indian Perns, and its invariable absence in those of Europe, are sufficiently remarkable; and probably indicate an aboriginal distinctness of species, though perhaps sufficiently allied to breed and merge together where they inhabit the same localities. M. Lesson also speaks of a *P. torquata*, *P. ruficollis*, and a *P. albogularis*, referring to his *Traité d'Ornithologie;* but if reposing only on differences of colour, I should be very slow to accept such diversities as specific].

9. *Milvinæ*. Genus [*Haliastur*, Gould.] *Haliaëtus!! Pondicerianus*, Auct. type. [*Milvus Pondicerianus*, apud Jerdon.] Leads from Eagles to Buzzards. [It is curious to remark the difference of opinion expressed with regard to the systematic position of this well known species. Thus Mr. Hodgson writes:— "Those who have classed the *Brahminee Cheel* of India with the fishing Eagles, may be safely said to know as little of the structure, as of the habits, of that paltry *Milvine* bird," &c. (*J. A. S.* VI, 368.) And Mr. Jerdon "nearly agrees" with him in opinion; even ranging it, as we have seen, in

Milvus (Madr. Jl. No. XXIV, 72.) Dr. Jameson, on the other hand, avers that "no person who has ever studied this bird in its native haunts on the Hoogly or the Ganges, where it occurs in vast numbers, in company with other *Haliaëti (!)*, would for a moment doubt where its proper position ought to be in the Ornithological system." *(Calc. Journ. Nat. Hist.* No. III, 318.) Mr. Gould, again, on referring a new Australian species to *Haliaëtus (P. Z. S.* 1837, p. 138), remarks that it is "nearly allied to *Hal. Pondicerianus*," thus doubly acknowledging the current arrangement of the latter, though he has since formed a particular section for these two species. For my own part, I have long regarded the true *Milvi* as being closely related by affinity to the *Haliaëti* or Ernes, and therefore find no difficulty in agreeing with Messrs. Hodgson and Jerdon as regards the proximity of the *Brahminee Cheel* to the Kites, while I still prefer to retain it as a subgenus of *Haliaëtus*, of which group I have already indicated three marked natural divisions, the present bird being characteristic of one of them.

10. *Astur (?) Dussumieri:* at least this species appears closely allied to two Australian Hawks *(approximans* and *cruentus)* recently referred to this genus by Mr. Gould, having the toes very much shorter than in restricted *Accipiter*;* but it would be better perhaps to institute a separate division for this intermediate form: *Accipiter Dukhunensis*, Sykes; and] *A. scutarius*, Hodgson, [Bengal Sporting Magazine, for 1836, p. 180; the young: noticed also in *As. Res.* XIX, note to p. 175, together with an *A. affinis* which, from the context, I much suspect is merely the adult.† N. B. Mr. Jerdon agrees with me in referring the specimens marked *scutarius* by Mr. Hodgson to the young *A. Dussumieri.*]

11. *Buteo canescens*, Hodgson, ('Bengal Sporting Magazine' for 1836, p. 180.) As few naturalists, but especially foreign naturalists, have the opportunity of consulting the work referred to, I deem it proper to quote the description, and shall offer some further remarks on the species.

It is a perfectly typical Buzzard, nearly allied to the European *B.*

* Vide *P. Z. S.* 1837, p. 98.

† The *Noctua Tarayensis* there mentioned is *Athene brama*, or *N. Indica*, Franklin; and the *N. tubiger* identical with *N. Brodiei*, Burton, *P. Z. S.* 1835, p. 152.

vulgaris. "Mature female twenty-three to twenty-four inches long, by fifty-four to fifty-six inches in extent of wings, and three lbs. and three-quarters in weight:" wing from bend sixteen inches and three-quarters to eighteen inches and a quarter, and tail ten to eleven inches: point of upper mandible to gape one inch and seven-eighths; and tarse three inches and a quarter, being plumed for the upper inch and a half. The male is considerably smaller, with wings fourteen and three-quarters to sixteen inches, and tail nine inches and a half to ten and a half.

The following is Mr. Hodgson's description of the plumage: "Female: — head, neck, and body below, white; dashed here and there with beauteous buff, and streaked narrowly and lengthwise on the cap and thighs with brown: tail, whitey-brown, with four to six narrow bars towards the end: back and wing-coverts, medial brown, the larger picked out with rufous: quills immaculate externally, and the great ones darker or black-brown; all the quills blanched internally except near their tips; but the primaries, immaculate; the rest, and especially the secondaries, shewing six brown bars across the inner vanes of the plumes: legs and cere dirty-yellow; bill blue, its hook and the talons black: iris hoary.

"Male smaller and less blanched. Young greatly more coloured than the mature female; above and the thighs saturate-brown, edged with rufous; below sordidly rufescent, or luteous, with large longitudinal dashes of brownish-red, changing to herring-bones on the thighs: tail brown, with deeper cross-bands prevailing throughout, and amounting to ten in number: iris brown; legs and cere, greenish."

From a series of specimens before me, however, it is quite clear that the brightly rufous-edged specimens are adults, while the young have but little trace of this colour, which is more or less confined to the scapularies and wing-coverts, and is besides comparatively very faint and pale; and that such *are* the young is demonstrated, not only by the less acuminate form of the nuchal plumes, but from the fact that one of them was killed while beginning to moult, and shews a few of the new bright rufous-edged feathers among its scapularies, which contrast strongly with the dull hair-brown colour of the rest of the upper-parts. A particularly fine female, received from Mr. Hodgson, may be described as having the dorsal plumage and smaller wing-feathers

slightly empurpled dusky, laterally somewhat broadly margined with bright rufous, which fades considerably as the feathers become old; head dull rufescent-brown, margined paler, with a vague whitish streak over the eyes, enlarging beyond them; feathers of the nape pointed and slender, white at base, with dusky terminal thirds edged laterally with rufous; those of the sides of the neck rufescent with dusky shafts, and edged laterally with whitish or hoary; throat white, with narrow dusky shafts, and the rest of the under-parts fulvous-white, with mottled dusky-and-rufous blotches on the feathers, inclining to form a sort of gorget on the breast, and always presenting a broad dark abdominal band, more or less developed (as in *B. lagopus*): lengthened tibial plumes dusky, tipped with dark rufous, or in some specimens of the latter hue, with merely dusky shafts: tertiaries and greater wing-coverts hair-brown, the former more or less distinctly barred on their inner webs, upon a whitish ground in some; the tips of the primaries and secondaries empurpled dusky, and the outer webs of the exterior primaries greyish to near the end; underneath, the wings display a very large white patch, constituted chiefly by the inner vanes of the primaries as far as their emargination, and the fore-part of the wing is dusky, broadly edged with rufous, of which colour are also the axillaries: tail rather faint rufous, with a nearly obsolete subterminal dark bar, its basal portion, and the exterior webs of all the outer feathers, dashed with cinereous. Other specimens have merely narrow mesial streaks of rufous, with dusky shafts, to most of the feathers of the under-parts, and the abdominal band paler and chiefly rufous; tail with little or no ashy tinge, indicating that such are less advanced in age. The immature plumage is of a generally more dingy cast, with no rufous below, even on the tibial plumes; the dorsal feathers are scarcely, when at all, margined with faint rufous; and the primaries and tail are minutely mottled and numerously banded: but these also vary in the amount of developement of their markings, both as regards the extent and depth of colouring.

According to Mr. Hodgson — "These birds are very common in the central and northern hilly regions of Nepâl; but I never," he remarks, "procured one from below. The species appears to be an oriental analogue of *B. vulgaris*. It adheres to the woods when the crops are up; but, after harvest, comes into the open country, and is

perpetually seen in the fields perched on a clod, and looking out for Snakes, which constitute its chief food. It also preys on Rats and Mice, and on Quails, Snipes, and Partridges; but is reduced to take the *birds* on the ground. I have seen it, however, make a splendid stoop at a Quail, which, after being flushed, chanced to alight on a bare spot, so as to be visible to the bird as he followed it with his eye on the wing and marked it settle. Teal and even Ducks are frequently slain by our bird in the same way. If he can perceive them take wing, even at half a mile's distance, he is up with them in an instant, and is sure to capture them, unless they are under cover in a moment after they touch the earth. I have carefully compared specimens of *vulgaris* and *canescens*, and cannot help thinking that the species are distinct; the breadth of the head and of the bill near it being so much more striking in the latter than in the former. Authors suppose that *Buteo vulgaris* is never found east of the Cape. Our bird is its representative."

Its representative no doubt on the Himalaya, but in Southern India there are two true Buzzards, the *B. longipes* and *B. rufiventer*, Jerdon, and in the Tenasserim provinces another, *B. pygmæus*, Nobis.]

12. *Elanus melanopterus:* [*Petite Buse Criarde* of Sonnerat, upon which are founded *Falco vociferus*, Latham, and *F. clamosus*, Shaw.]

13. *Accipiter* [*nisosimilis*, Tickell, *J. A. S.* II, 571: *A. nisus* vel *fringillarius* of Jerdon and others. It differs from the European species in its larger size, and in having constantly a long superciliary white line; the markings of the under-parts are also somewhat different.

14. *Milvus* [*cheela*; *Falco cheela*, Gmelin: *M. govinda*, Sykes; *M. œtolius*, Lesson. *N. B.* I thought at first that the specimens sent of this bird presented certain differences from the common Indian Kite, but subsequent comparison of them with numerous examples of the latter has convinced me of their identity.]

15. *Falco peregrinus:* [*F. calidus*, Latham.]

16. *Falco* [*juggur*, Hardwicke and Gray; *F. luggur*, Jerdon] (*Lagger*, *Jhagger*, Indicè, *Maset*, fœm.)

17. *Falco tinnunculus.*

18. *Buteoninæ.* Genus *Butastur*, Hodgson. *Buteo teesa*, Auct., type. [*Circus teesa*, Franklin; *Astur Hyder*, Sykes.] It differs from the true

Buzzards in its less corpulent form, and general adaptation for more active habits: the tarsi are longer and more prominently scutellated in front, the toes also being scutellated above nearly to their base, and the talons are comparatively powerful. The markings also are somewhat peculiar, and recal to mind those of various South American *Raptores;* but still manifest a relationship to the true Buzzards, which is further conspicuously shewn by the rufous tail.

19. *Falconinæ.* Genus *Hyptiopus* (Hodgson, olim *Baza, H.* [*lophotes; Falco lophotes,* Temminck: *Lophotes Indicus,* Lesson; *Buteo cristatus,* Vieillot; *Colvy Falcon* of Latham; *Falco Lathami,* J. E. Gray, and since *Lepidogenys Lathami.* G. R. Gray; *Baza syama,* Hodgson, *J. A. S.* V, 777, which latter generic name has precedence of *Lepidogenys,* while *Lophotes* is pre-occupied in Ichthyology. Moreover, I do not consider this form to appertain to the Falcon group, but decidedly to that of the Perns and Elans.] Type.

20. *Falco chicquera.*

21. *Ierax* [*Bengalensis: Little Black and Orange-coloured Hawk* of Edwards, erroneously regarded as the female of *I. cœrulescens* by various authors. Vide p. 180,* *ante.*

22. *Ketupa Leschenaultii,* Lesson: *Strix Hardwickii,* Gray: *cultrungris nigripes,* Hodgson, *J. A. S.* V. 364, and mentioned in VI, 363. Identical with specimens from Southern India and the Tenasserim provinces.]

23. *Mesomorpha* (Hodgson, olim *Urrua,* H.) [*Bengalensis; Otus Bengalensis,* Franklin, Gould: *Bubo ? cavearеus,* Hodgson, *As. Res.* XIX, 169, and since *Urrua cavearea,* H., *J. A. S.* VI, 372; altered to *Mesomorpha,* Ibid. X, 28, where various other prior appellations are similarly changed and classicized; *Urrua Bengalensis,* Jerdon.] Type.

24. *Meseidus* (Hodgson, olim *Bulaca,* H.) *Newarensis* [*Ulula ? Newarensis,* Hodgson, *As. Res.* XIX, 168; *Bulaca—Id. J. A. S.* VI, 372; *B. monticola,* Jerdon, *Supplement.*] Type.

25. *Strix flammea:* [*Str. Javanica,* apud Jerdon.]

26. Genus *Ninox,* Hodgson: type. *N.* [*scutulatus; Strix scutulata,* Raffles, *Lin. Trans.* XIII, pt. II, 280: *Str. hirsuta,* Tem.; *Str. lugubris,* Tickell, *J. A. S.* II, 572; *Ninox Nipalensis,* Hodgson, *Madr. Jl.* No. XIV, 23, with figure; *J. A. S.* VI, 364, where the singular paral-

lelism of proportions manifested by this species and the Hawk *Hyptiopus lophotes* is noticed in minute detail.

27. *Athene cuculoides;*] *Noctua cuculoides*, Vigors and Gould. [This bird* is found in Southern India and in the Tenasserim provinces].

28. *Scops lettia*, Hodgson [*As. Res.* XIX, 176: *Scops Lempiji (?)*, Horsfield, vel *Sc. Javanicus*, Lesson, to which an Assamese specimen is referred by Dr. Horsfield. I incline to suspect that the *Sc. Sunia*, Hodgson, Ibid., will prove to be merely the young, as the "Red Owl" of Wilson's 'American Ornithology' is of his "Mottled Owl", *(Sc. Asio)*.

29. *Athene radiatus; Strix radiata*, Tickell, *J. A. S.* II, 572; *Athene erythropterus*, Gould, *P. Z. S.*, 1837, p. 136;] *Noctua perlineata*, Hodgson [mentioned in *J. A. S.* VI, 369].

30. *Lophophorus Impeyanus.*

31. *Tragopan satyrus.*

32. *Euplocomus leucomelas.*

33. [*Ithaginis* (Wagler;) *Plectrophorus*, J. E. Gray; *Ptilopachus*, Swanson;] *cruentata.*

34. *Gallophasis* (Hodgson, type,) *pucrasia.* [*Phasianus pucrasia*, Vigors and Gould. This bird certainly does not rank well in any of the divisions hitherto established among the Pheasants. Its distinctive traits consisting in the absence of any nude crimson space around the eyes, in the similarity of the sexes, the peculiar character of the plumage, and the short straight tail; but it approximates the restricted *Phasiani* more than it does any other group, and it is remarkable that the only Indian species of true Pheasant *(Ph. Wallichii* vel *Stacei)* differs from the rest in being crested, though much less heavily than the present bird, which latter is known to sportsmen by the names *Plass*, *Pucrass*, and *Koklass.*

* The Society has just been presented with a specimen from Chusan.

Proceedings of the Asiatic Society.

(Wednesday Evening, 12th April, 1843.)

Present.

Sir J. P. Grant, Knight,
Sir W. H. Seton, Knight,
Lieutenant Colonel, W. N. Forbes, C. B.
H. Torrens, Esq.
R. Houstoun, Esq.
Captain A. Broome,
N. B. E. Baillie,
S. G. T. Heatly, Esq., and others.

The Honorable W. W. Bird, President, in the chair.

The President opened the business of the evening by expressing his thanks to the Society for electing him as its President. He observed, that he was one of the oldest, if not the oldest, member in India; that he felt both pride and gratification in the honor conferred upon him, and would use his best exertions to uphold the credit of the Society, which had attained so much celebrity in the estimation of the scientific world. The President observed, that although he could not promise much, individually, to the Society in scientific matters, yet from his position in Society, he was satisfied that he could influence largely valuable contributions. That he had been in some measure successful in this hope, in as much as he had prevailed upon Mr. H. Torrens, the late Honorary Secretary, to continue his labors as such for the Society, aided by a stipendiary Sub-Secretary. This point was not of immaterial importance when the difficulty of procuring men of scientific attainments, and with the other qualifications requisite to fit them for the multifarious duties of Secretary to the Society was considered; and this was feelingly illustrated by the President in the case of their late illustrious Secretary, Mr. J. Prinsep, who sacrificed his life in the ardour of his scientific researches to benefit the Society. The President concluded by referring to a memorandum which had been prepared at his request, for the future conduct of the business of the Society by the Honorary Secretary, and which was read as follows:—

At a Meeting of the Committee of Papers held at Government House, on the 1st April, 1843:—

Present

The Honorable the President.
Sir H. W. Seton, Knight,
Lieutenant Colonel W. N. Forbes, C. B.
Lieutenant A. Broome.
H. Torrens, Esq. Officiating as Secretary to the Committee.

Read the following Memorandum.

Resolved.—That its substance be generally approved, and that it be submitted to the Society at the ordinary Annual Meeting for the appointment of Officers of the Society, to be held on the 12th April.

H. Torrens,
Officiating as Secy. to the Committee.

The Honorable the President has expressed a wish, that I should lay before him a Memorandum of the course expedient to be taken with reference to the conduct of the business of our Society by an Honorary Secretary.

The Honorable the President desires, that the office of Secretary should continue to be held as an honorary appointment. It is the wish of the Society generally.

But I have explained to him the impossibility of procuring the entire services of any honorary holder of the office, and he has acquiesced in the expediency of engaging a Sub-Secretary to conduct ordinary correspondence with current business, and to assist, under the Secretary, in the editing of the Journal lately my property, which the Society desire to take over, and make their own.

I have now to suggest the mode in which the Sub-Secretary may be remunerated, without inducing extra charge to any serious extent upon the Society. And here let me observe, that I intend submitting to the Society, with the sanction of the Honorable the President, the nomination of Mr. Henry Piddington, our Geological Curator, to the duty. His general acquaintance with the principles of science; his long experience of this country, its usages, and its people; his literary qualifications; his habits of business; and last not least, his well-known zeal for science, his mental powers and his energetic use of them; render him more eligible for the very miscellaneous and peculiar duties which he could be called upon to perform as Sub-Secretary than any person with whom I am acquainted in Calcutta or in India. I have had good reason to know how well he could perform those duties by my experience of the manner in which he has already assisted me in my attempts to perform the work of Secretary.

Having thus premised, I proceed to note my scheme.

1. That there be an Honorary Secretary to the Society, charged either alone, or as associated with other Honorary Secretaries, with the special duty of conducting the department of Oriental Literature.

2. That he be answerable to the Society for the proper disposition of their funds, under the immediate instructions of the President.

3. That he be further answerable to the Society, for the due and proper conduct of

their correspondence, foreign and internal, and that he have the supervision of the publication of the Journal.

4. That he be assisted by a Sub-Secretary, whose duty will be to act under the Secretary for the purposes noted in No. 3, as also for the general charge of the premises, and property of the Society; to check all petty charges and disbursements in the departments of Curator and the Museum, and the Curator of the Museum Economical Geology, before submitting them to the Secretary, and to assist in editing the Journal of the Society under that officer.

5. That he be paid for these services, 200 rupees a month.

And here is the supposed difficulty, the procuring of funds for this salary.

Now the interest of our funded monies—Rupees 13,000, Csoma de Koros' legacy (Rs. 4000) not included; gives about 60 (sixty) rupees a month.

The appointment of a Sub-Secretary will render superfluous that of the Museum Clerk employed under the Librarian on 60 (sixty) rupees a month. The demand from Government of the payment of the contingent charges of the Museum Economic Geology, averaging about 40 (forty) rupees a month will save the Society this sum,* and render it so much available for general purposes.

Thus we should have:—

Interest, ...	60	Rs. per Mensem.
Salary saved, ...	60	
Charges saved, ...	40	
Total Rs.	160	

The residue necessary for the complement of 200 rupees, may be easily spared out of the sum (about 4,000 rupees,) which used to be spent annually by the Society in the purchase of the Journal for their members, and I can safely say, that the expense will be more than trebly covered by the saving which close supervision and better management must induce in the cost and charges of editing the Journal as the property of the Society.

I would have suggested the re-organization of our Accountant's Office and Assignment to the Sub-Secretary of the duties belonging to it, but I cannot recommend that scheme.

The Sub-Secretary should be relieved from all financial responsibility, and be left to devote himself to the active duties of his peculiar position. Mr. PIDDINGTON, with his other work, will have, as I see he has now, more than ample occupation for all his time in the Sub-Secretariat, the duties of which he is indeed experimentally performing.

Sub-Secretary's Salary.

Interest, ...	60
Salary saved, ...	60
Costs ditto, ...	40
Allowed from Journal, ...	40
Total Rs.	200

As the contingent charges of the Museum Economic Geology, may be occasionally under 40 rupees, it might be well to rate our new outlay at 50 rupees a month, for

* I never sent in this bill to Government, keeping the demand until the Museum Rooms for the institution had been built at the Society's cost and charges, when it might justly be made.

which the Society will secure efficiency of a sterling character in the important duties of their Secretariat.

Should the Society, as noted by the Honorable the President, think my services as Honorary Secretary of any value, I willingly offer those, though save as respects some portion of Oriental Literature, they are very worthless. H. Torrens.

March 24, 1843.

N. B.—Serious and severe illness has delayed the preparation of this paper.

This memorandum having been again read to the meeting was unanimously passed and approved, and Mr. H. Torrens was accordingly appointed Honorary Secretary, and Mr. H. Piddington Sub-Secretary to the Society, under his superintendence, upon a salary of Rs. 200 per month.

Sir L. Peel, Chief Justice, and W. Seton Karr, Esq., proposed at the former meeting were ballotted for, and unanimously elected as members of the Society.

Ordered.—That the usual communication of their election be made to Sir L. Peel and Mr. Karr, and that they be furnished with the rules of the Society for their guidance. The following gentlemen were proposed as Members of the Society:—

Lieut. R. Strachey, B. E. proposed by Lieut. Baird Smith, B. E., seconded by Mr. Piddington.

Capt. Goodwyn, B. E. proposed by Lieut. A. Broome, B. H. A. and seconded by Lieut. Col. Forbes.

The Honorable H. T. Prinsep was also proposed as a Honorary Member by the Honorable the President, seconded by Sir H. Seton.

Library.

The following Books were presented:—

Books received for the Meeting of the Asiatic Society, on the 12th April 1843.

The Calcutta Christian Observer, April, 1843. Presented by the Editor.

The Oriental Christian Spectator. Bombay, February and March 1843. Presented by the Editor.

The Calcutta Literary Gleaner, March and April 1843. Presented by the Editor.

Proceedings of the Academy of Natural Sciences of Philadelphia, 1841-42. vol. 1. Nos. 1 to 16, from the Academy.

List of the Members and Correspondents of the Academy of Natural Science of Philadelphia, 1841, from the Academy.

Second Bulletin of the Proceedings of the National Institution for the promotion of Science. Washington 1842. Presented by Dr. Harlan.

Redfield on Whirlwind Storms, with replies to the Objections and Strictures of Dr. Hare. Presented by the Author.

Redfield's Reply to Dr. Hare's further objections relating to Whirlwind Storms. Presented by the Author.

State of New York, in Assembly, January 1840. No. 50, and February 1841, No. 150. Presented by Mr. Morton.

Bernier's Travels, translated from the French by J. Stuart. Calcutta, 1826. Presented by Dr. Roer.

Nicollet's Essay on Meteorological Observations. Presented by Dr. Morton.

Morton's Description of some new species of organic remains of the Cretaceous Group of the United States. Presented by the Author.

Morton's Inquiry into the distinctive characteristics of the Aboriginal race of America. Presented by the Author.

Catalogue of Skulls of Man and the inferior Animals, in the collection of S. G. Morton. Presented by Dr. Morton.

Morton's Memoir of William Maclure, Esq. Presented by the Author.

Morton's Remarks on the so-called Pigmy race of the Valley of the Mississippi. Presented by the Author.

Morton's Some Remarks on the ancient Peruvians. Presented by the Author.

Audubon and Bachman's description of new species of Quadrupeds inhabiting North America. Presented by Mr. Morton.

Wood's Memoir of the Life and Character of the late J. Parrish. Presented by Dr. Morton.

Roger's Third Annual Report on the Geological Survey of the State of Pennsylvania. Presented by Dr. Morton.

Morton's Crania Americana (from the American Journal of the Science and Arts, No. 2. vol. 38. Presented by Dr. Morton.

Say's Descriptions of some new Terrestrial and Fluviatile Shells of North America. Presented by Dr. Morton.

Pinnock and Moore's Report of Experiments on the Action of the Heart. Presented by Dr. Morton.

Report on the strength of materials for Steam Boilers. Presented by Dr. Morton.

Wight's Icones Plantarum Indiæ Orientalis, vol. ii. part Iv, from the Government of India.

Morton's Crania Americana, or comparative view of the Skulls of various Aboriginal Nations of North and South America. Philadelphia, 1839. Presented by the Author.

Herapath's Railway and Commercial Journal, January 7th, 1843, vol. v. No. 178.

Read the following papers; viz. Letter No. 502, dated 29th March, 1843, from Mr. Secretary Thomason, transmitting a report by Lieut. J. D. Cunningham, of Engineers, on the province of Kunawar and the adjacent Bhotee districts, for publication in the Society's Journal, should it be deemed fit to do so.

Letter from Lieut. R. Baird Smith, of Engineers, of 25th March, 1843, forwarding for publication in the Journal the first part of a Memoir on Indian Earthquakes.

Letter from Mr. Officiating Secretary Halliday, of 3rd March, 1843, forwarding for presentation to the Society, a volume of Icones Plantarum

India Orientalis, or Figures of Indian Plants, by Surgeon R. Wight, of the Madras Establishment.

Letter from Sam. George Morton, Esq. of Philadelphia, of 4th Aug. 1842, forwarding for presentation to the Society, a copy of his "Crania Americana," and requesting to be furnished with skulls of Hindoos and other oriental nations, to aid him in the pursuit of his comparative investigations, which now embrace all the races of men.

Letter from B. H. Hodgson, Esq. dated 1st instant, communicating that Mr. Howard is about to come forth in the present month with the first division of the Zoology of Nipal (Mammalia), and that he expects half the price of each division of the work, or Rs. 25, to be paid in advance.

Read the following report from the Officiating Secretary:—

1. The Officiating Secretary reports, that having, as was desired, made enquiries as to the expence of raising the whole roof over the stair-case instead of a skylight, he is informed that this would cost at least 800 Rupees: Mr. Bolst, our architect, thinks it very dangerous to undertake, with reference to the state of the architrave beams round three sides of the square and that of the screen wall on the fourth. By taking away the shelves on brackets which support the model of the Taj, and that of the Lama temple, and by opening the doors of the new rooms, bird-room and fossil room below, it has been found that a sufficient light for the objects intended to be placed below the stairs may be obtained. It is therefore thought by Mr. Torrens and himself, that for the present the skylight may be dispensed with

2. It was reported at the January meeting, that Major Troyer had advised the Secretary that the French Government had renewed the allowance of 1500 francs, (650 Rs.) for copying the Veds. Upon a reference to the French Government at Chandernagore, the authorisation which this letter contains has been received, and when the money is brought to account, the Society will debit the French Government with the balance of 233 : 7 : 9 Rs., due from it to the late Mr. J. Prinsep's estate, and which was provisionally paid by the Society. See Proceedings for June 1839.

The arrangements for continuing the copying have been duly made, and the work is in progress.

It would be highly advisable that the Society should determine as to what individuals and Societies the Journal should be sent. The American Societies and some individuals in that country are most attentive in sending us their publications, as also some in France. As will be noted by the accompanying letters, we are much arrear with our American friends. I have obtained a list of our present distributions, which is annexed, and I may mention the Academie Royale de Bordeaux as a public body regularly forwarding to us its transactions, but, as it would appear, not receiving our Journal.

List of the Journal of the Asiatic Society distributed gratis on behalf of the Society, by Messrs. Allen and Co. of London.

Professor Wilson, ...	1
Asiatic Journal, ...	1
Royal Society, ...	1
Royal Asiatic Society, ...	1
Edinburgh Philosophical Journal, ...	1
Royal Institution, ...	1
Philosophical Magazine, ...	1
Athenæum, ...	1
Professor Heyne, ...	1
Baron Von Hammer Purgstall, ...	1
University of Bonn, ...	1
Royal Society of Edinburgh, ...	1
Spectator, ...	1
Professor Schlegel, ...	1
	14
Dispatched direct from Calcutta, to Major Troyer, Paris,.....	10
Sir H. T. De la Beche, ...	1
Total.....	25 Copies.

Read the following letters of 12th instant, and lists from Dr. Roer Librarian.

To H. Piddington, Esq. Acting Secretary, Asiatic Society.

Sir,—In continuation of my arrangement of the Antiquities of our Museum, I have the honour of forwarding three lists to you; viz. of the armour, of the musical instruments, and of the models of implements, tools, specimens of manufacture of the natives of India and other Asiatic nations. The arrangement of those articles has now been completed, and it is satisfactory to me to inform you, that the names of the donors and the locations of the greater part of them have been ascertained and duly noted.

I have the honour, to be, Sir,
Your obedient servant,
G. Roer.

12th April, 1843.

Models of Implements, Tools, Machines, &c.

1. A Hindustani plough, called Hal. Donor Miss Tytler. As. Res. Vol. xv. App. xxxv.
2. A Hindustani drill plough. Donor ditto ditto.
3. Model of a native plough. Donor G. T. Lushington, Esq.
4. A Javanese plough. Donor Capt. T. Fiddes. As. Res. Vol xiii. App. xvii.
5. Plough used by the Parbuttiahs. Donor Dr. A. Campbell.
6. Instruments for digging and clearing lands of weeds. Donor Miss Tytler, As. Res. Vol. xv. App. xxv.
7. A Hindustani spade, called Phaura. Donor ditto ditto.
8. A spade, called Koo by the Newars, and Kodalli by the Parbuttiahs. Donor Dr. A. Campbell.

9. Three Hindustani sickles or Hansuas. Donor Miss Tytler. As. Res. Vol. xv. App. xxv.
10. Henga, an instrument for pressing the seeds into the ground, and breaking clods, like the English roller. Donor Miss Tytler, As. Res. Vol. xv.
11. An instrument, called Kurmaghan by the Newars, used for breaking the clods and pressing the soil. Donor Dr. A. Campbell.
12. Roochi-mughan, used to cover sown wheat and gogha, or Upland rice. Donor ditto ditto.
13. Chassa-mughan, used to smooth the flooded beds, in which the seeds and taki are sown, and also to prepare the soil for sowing vegetables, pepper, (red) ginger, &c. Donor ditto ditto.
14. Poo-retcha, used for weeding the dry rice. Donor ditto ditto.
15. Chong-kuki, used for weeding the dry rice. Donor ditto ditto.
16. Rúé, used for spreading grain and collecting it in heaps after its removal from the straw. Donor ditto ditto.
17. Rúti, used for making chawl, (rice) from dhan and for pounding bricks. Donor ditto ditto.
18. Chon-rumna. Donor ditto ditto.
19. A dhunki, or chalni, used for separating grain from the husk. Donor Miss Tytler. As. Res. Vol. xv.
20. Another, ditto ditto.
21. Ukhli-músel, or pestle and mortar for separating grain from the husk. Donor ditto ditto.
22. Dhenki, used for ditto ditto. Donor ditto ditto.
23. Ooghan-okua, used by the Parbuttiahs for ditto ditto. Donor Dr. A. Campbell.
24. Sup, used for winnowing corn. Donor Miss Tytler. As. Res. xv.
25. A model, shewing the manner in which the oxen tread out the corn. Donor ditto ditto.
26. A mill for grinding corn, called by the natives janta-chakhi. Donor ditto ditto.
27. Another ditto ditto.
28. Model of a grinding stone. Donor ditto ditto.
29. A kolhu, or Hindustani oil mill. Donor ditto ditto.
30. An oil press, called Chikon-sa. Donor Dr. A. Campbell.
31. Model of the native mill for grinding mustard-seed. Donor G. T. Lushington, Esq. As. Journal, iv. p. 56.
32. A sugarcane-mill or press, called Tura by the Newars, and Rula by the Parbuttiahs. Donor Dr. A. Campbell.
33. A water-mill, called Pan-Chaki on the Northern Doab and Western hills, and Kan by the Newars. Donor ditto ditto.
34. Model of a still for distilling spirits, made of the original materials. Donor Miss Tytler. As. Res. Vol. xv.
35. Model of a still for distilling rose water, made of the original materials. Donor ditto ditto.
36. Múlí, a machine for raising water from the well. Donor ditto ditto.
37. Mut, used in Hindustan for raising water. Donor ditto ditto.
38. A machine for raising water. Donor ditto ditto.
39. A bambú basket with which the natives of India water the rice fields. Donor ditto ditto.
40. Koring, a Persian wheel for watering land from a tank or ditch. Donor ditto ditto.
41. Cherkhi, used for separating the seeds from the cotton wool. Donor ditto ditto.
42. A ditto ditto.
43. Dhunki, an instrument in two pieces for beating cotton after the seeds have been separated. Donor ditto ditto.
44. Kaman, a bow with which the spinner beats cotton. Donor ditto ditto.
45. Cherkha, spinning wheel of India. Donor ditto ditto.
46. Model of the native spinning wheel. Donor G. T. Lushington, Esq. As. Journ. vol iv. p. 56.
47. A Weaver's Loom, with a weaver, holding a shuttle in his hand. Donor Miss Tytler. As. Res. vol. xv.
48. Model of an instrument, shewing the first stage of preparation for the loom. Donor ditto. ditto.

49. Model of an instrument, shewing the second stage.
50. Reel, in which the skeins of thread are put. Donor ditto ditto.
51. Pareta, or reel of India. Donor ditto ditto.
52. Model of a Loom for weaving bohhin and tape.
53. Ditto ditto, for weaving Hindustani woollen carpets.
54. Ditto ditto, for cotton carpets, called satrinjé.
55. Another ditto ditto.
56. Ditto, for preparing chicks.
57. Ditto ditto, jhalar.
58. Part of the Floor of a House, where golden thread is prepared.
59. An Apparatus for drawing golden thread.
60. A ditto silver thread.
61. A Loom for weaving coarse canvas. Donor ditto ditto.
62. A ditto ditto.
63. A ditto for weaving blankets. Donor ditto ditto.
64. Model to make embroidered cloth. Donor ditto ditto.
65. A Machine for preparing single threads from the leaves of the sirkhi grass. Donor ditto ditto.
66. A hundle of Hemp Cords. Donor ditto ditto.
67. Daéra, instrument for spinning hemp. Donor ditto ditto.
68-69. Two Instruments to twist thread. Donor ditto ditto.
70. An Apparatus, used in Hindustan for making butter. Donor ditto ditto.
71. Model of a Saw, used by the natives of Hindustan. Donor ditto ditto.
72. Ditto of an Instrument for drawing circles on the ground with carpenter's hatchets and saw. Donor ditto ditto.
73-92. A variety of Tools and Instruments.
93. A small Harpoon. Donor R. Home, Esq. As. Res. xii.
94-97. Various Tools.
98. A Chak or Potter's Wheel. Donor Miss Tytler.
99. Model of a Potter's Instrument for preparing earthen pots. Donor ditto ditto.
100. Model of a Blacksmith's Forge and Bellows, with two anvils. Donor ditto ditto.
101. Model of a steel-yard. Donor ditto ditto.
102. Model of the steel-yard, used by the natives for weighing, (called túlah.) Donor Raja Kali Kishen Bahadur.
103. Model of an Apparatus, for catching birds. Donor Miss Tytler.
104. Ditto of a Frame, for making tallow candles. Donor ditto ditto.
105. Ditto of an Apparatus, for making paper. Donor ditto ditto.
106-110. Five wooden Stereotypes from Tibet.
111-133. Twenty-three Models of Kitchen Utensils of Hindustan.
134. A native cart. Donor Miss Tytler, As. Res. Vol. xv.
135. A bullock cart, for conveying gram. Donor G. T. Lushington, Esq.
136. A Girth, for a hullock.
137. Ruth, native carriage drawn by hullocks. Donor G. T. Lushington, Esq.
138. Ekha-garee, carriage drawn by one horse. Donor Miss Tytler.
139. Ruth, drawn by two horses. Donor G. T. Lushington, Esq.
140. Sagur-garee. Ditto ditto.
141. A Carriage, for females. Donor Miss Tytler.

B. Specimens of Manufacture.

a. Of Cloth.

142. Specimen of Erria cloth (once washed.) Donor Dr. R. Tytler.
143. Specimens of Erria cloth. Donor ditto ditto.

144. Toos, a sort of coarse cloth, (unwashed.) Donor ditto ditto
145. Toos, white cloth (20-22 Rs. per Than of 27 by 1 yard.) Donor ditto ditto.
146. Mulida, dark-red cloth. (5 Rs. per Than of 7½ yards, broad 1 yard.) Donor ditto ditto,
147. Mulida, blue, (5 Rs. a Than.) Donor ditto ditto.
148. Nimbee, blue, (3 Rs. 8 As. per Than of 8 yards.) Donor ditto ditto.
149. Penchan, white cloth, (30-34 Rs. per Than of 27 by 1 yard.) Donor ditto ditto.
150. Punkhee, white, (2 Rs. per Than of 9 by 1 and 2 yards.) Donor ditto ditto.
151. Nimboo, green, (3 Rs. 8 As. per Than of 8 yards.) Donor ditto ditto.
152. Specimens of Mugah cloth, (unwashed.) Donor ditto ditto.
153. Cloth of the floss of the Mugah. Donor ditto ditto.
154. A piece of coarse Cotton (unwashed.)
155. A piece of striped Cotton. Donor H. Torrens, Esq.
156. A piece of white Cotton.
157. A coarse kind of red Cloth.
158. A Blanket of cotton and cotton thread.
159. A woollen Blanket, (striped.)
160. A Scarf.
161. A ditto ditto.
162. A piece of Cloth, made of the bark of the mulberry tree of the Friendly Islands. Donor Capt. P. Dillon. As. Res. Vol. xvi. App. v.
163-70. Eight ditto ditto.
171. Specimens of Cloth, made by the Javanese from the bark of the Upas tree. Donor Dr. R. Tytler.
172. A Coat, made of the bark of a tree, (Java.)
173. A Chandua, (cotton cover against the dew.)
174-198. Specimens of cotton and wool, manufactured at Nepaul, Tibet and Botan. Donor Dr. A. Campbell. As. Journ. vol. v. p. 127.
199. English Shawl from Herat.
200. Specimens of Tibetan sheep wool and cloth.
201. Ditto ditto of goats' wool.
202. Ditto ditto of Bactrian camel.

b. Of other Articles.

1. From India.

203. A Box to keep chunam, (lime.)
204. A Box to keep shindúr, (Vermillion.)
205-206. Two small wooden Boxes from Java.
207. Golap-pass, a silver vessel for sprinkling rose-water.
209-211. Models of a complete set of the hooka. Donor Miss Tytler.
212. A square Lantern of tin.
213. Silver ornament of a horse.
214. Bridles and Ornaments of a horse, (in a state of great decay.)
215-16. Two marble Cows with calves, from Joypore.
217. Ditto ditto Elephant, mounted.

218. Ditto ditto Horse, mounted.
219-20. Two wooden Horses, mounted.
221-222. Two wooden Elephants.

2. From Ava.

223. A set of playing Cards. Donor Dr. Tytler. As. Res. Vol. xvi, App. xiii.
224. Dominos. Donor R. Home, Esq. As. Res. Vol. xii, App. xxx.
225-27. Three metal Boxes.
228-29. Two more of a different shape.
230-60. Thirty-one specimens of Burmese Lacquered or Japanned-ware from Ava. Donor Major Burney. As. Journ. Vol. i, p. 158.
261. Instrument for fixing the varnish.
262. Paper, made of the remains of vegetable matter, remarkable for its hygrometrical quality. Donor Mr. Swinton.
263. Paper made in India.
264-65. Two pieces of Leather, dressed with oil and tallow. Donor Mr. Swinton. 1833.

3. From Nepal.

266 Ornamented Chata. Donor Dr. L. Burlini.
267. Ditto ditto. Donor Miss Tytler. As. Res. Vol. xv.
268-69. Two Steels for striking fire. Donor J. Brown, Esq. As. Res. Vol. xii. App xxi.
270. A Bowl of a Pipe, made of Arracan clay. Donor Dr. R. Tytler. As. Journ. Vol. v. May 1836.
271-72. Two Inkstands. Donor Dr. A. Campbell.
273-274. Two Inkstands with pencase, of peculiar construction.
275. A ditto ditto of copper.

4. From Tibet.

276-79. Four pairs of Spectacles. Presented by the Government of India. As. Res. vol. xvii. p. 622.
280. A pair of Eye-covers. Donor ditto ditto.
281. An Eye-cover, (Tibetan?)
282. A pair of ear-covers Donor Government of India.
283. A ditto ditto, (Tibetan?)
284. A Fan. Donor ditto ditto.
285. A ditto in a case. Donor ditto ditto.
286. A silk Fan Case, (Tibetan?)
287. A silk Purse. Donor ditto ditto.
288. A silk Bag. Donor ditto ditto.
289. A ditto ditto, (Tibetan?)
290. A silk Cover, (Tibetan?)
291. A Brush with napkin. Donor ditto ditto.
292. A Watch Case. Donor ditto ditto.
293. Inkstand and Case. Donor ditto ditto.
294. Knife and Sticks. Donor ditto ditto.
295. Ditto ditto.

296. A wooden Cup. Donor ditto ditto.
297. A pair of Mogul Boots. Donor ditto ditto.
298. A ditto Shoes. Donor ditto ditto.
299. A Lantern in a tin case. Donor ditto ditto.
300. A ditto in a red box. Donor ditto ditto.
301. Cover for a snuff box. Donor ditto ditto.
302-304. Three Prayer Cylinders.
305. A Cashmere Box. Donor Mr. Moorcrooft. 1833.

5. From China.

305. Four pair of Tea Cups and Saucers, from Ningpo. Donor Lieut. J. Brockman, Asiatic Journal, Vol. xi. p. 582.
306. Two ditto of Sugar-pots with plates. Donor ditto ditto.
307. Two plain Cups with covers. Donor ditto ditto.
308. A metallic Cup and Saucer. Donor ditto ditto.
309. Four porcelain Spoons. Donor ditto ditto.
310. A Tea-pot. Donor ditto ditto.
311. A pair of Wall Flower Vases. Donor ditto ditto.
312. Lock and Key. Donor ditto ditto.
313. A pair of Scales on the principle of the Steel-yard in a wooden box. Donor ditto ditto.
314. An Opium Box of tortoise-shell. Donor ditto ditto.
315. A brass Button of a Mandarin's cap. Donor ditto ditto.
316. A Coat made of Fur. Donor ditto ditto.
317. A Figure made of soap-stone. Donor ditto ditto.
318. A Mandarin's Cap. Donor Mr. F. D'Cruze.
319. A silk Scarf. Asiatic Journal, Vol. v. p. 383.
320. Soles of Chinese Shoes.
321. Chinese Chatta-hat of palm leaves. Donor Gen. Hardwicke. As. Res. Vol. xv. App. xxxiii.
322-26. Chinese Hats of sizes.
327. Model of a China Lady's Foot. Donor W. K. Ord, Esq. As. Res. Vol. xvi. App. xxi.
328. An Oil-burner.
329. A Pipe.
330-31. Two ditto. Donor R. Home. Esq. As. Res. Vol. xii. App. xxiv.
332-36. Five Pipes from Chinese Tartary.
337-38. Two Compasses. Donor R. Home, Esq. As. Res. Vol. xii. App. xxiv.
339. A set of China Chopsticks. Donor ditto ditto.
340. A ditto ditto.

Ornaments, Ornamental Implements, Dresses, &c.

341-46. Ornaments, worn by the Ooriah women, consisting of 4 Bracelets, a Ring and an Ear-ring. Donor Baboo Ramcomul Sen, As. Journ. Vol. v. p. 559.

347-48. Two brass Sticks for putting black powder into the eyes, used by the Hindus.

349. A brass Stick to colour the forehead.

350. An Ornament for the arm, worn by the natives of India.

351-52. Two brass Bracelets.

353. Lac Bracelets, used by the women of India. Donor Miss Tytler, As. Res. Vol. xiv. App. iii.

354-56. Three Armlets, worn by Shuniasis.

357-58. Two pair brass Bracelets, worn by Shuniasis, (from Java.)

359. Necklace of Shells. Donor Col. Morrison. 6th Nov. 1839.

360. Another smaller one.

361. Necklace of Seeds and Shells from Gurangupune. Donor J. Palmer, Esq., As. Res. Vol. xiv. Appendix xxix.

362-63. Two more of Shells.

364. A Necklace made of tulushi wood, and worn by the worshippers of Vishnu.

365-66. Two Necklaces of a kind of nut, worn by the worshippers of ditto.

367. Rudracsha Mala. Donor H. H. Wilson, Esq. As. Res. Vol. xii. App. xxiii.

368. A Necklace of Stone, worn by Fakeers.

369. A ditto ditto.

370. A ditto ditto.

371. A Hindu Beggar's Dress and Bag.

372. A ditto ditto Begging Dish made of Human Skull.

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*Models of Implements, Specimens of Manufacture, Utensils, &c. from the Eastern. Islands.**

373. An Instrument to strike fire, from King George's Sound. Donor J. H. Stocqueler, Esq.

374. A Mallet from ditto ditto. Donor ditto ditto.

375-77. Three Wooden Dishes from the South Seas, Manicola, Tucopia and Majeer. Donor Capt. P. Dillon.

378. Fishing Line, &c. from the Eastern Islands. Donor R. Home. Esq. As. Res. Vol. xii. Appendix xxiv.

379. Sling from ditto ditto. Donor R. Home, Esq.

380. Ditto ditto.

381. A carved Ornament of a boat.

382-87. Pillows from the Friendly Islands. Donor Capt. P. Dillon. As. Res. Vol. xvi.

388. A Box from the Eastern Islands.

389. A Work Box from ditto ditto.

390. A Box from New Zealand. Donor Capt. P. Dillon, As. Res. Vol. xvi. App. ix.

391. A Work Box from ditto ditto. Donor ditto ditto.

392-93. Two carved Musical Instruments from the Eastern Islands.

394. Bracelets of Shells from ditto ditto.

* See also 162 to 172.

395. Bracelets of Boar Tusks. Donor R. Home, Esq. As. Res. Vol. xii. p. 23.
396. Ornaments from——
397-402. Mangeer Fans.
403-4. Two mother of pearl shell Ornaments of New Zealand Chiefs. Donor Gen. Hardwicke. As. Res. Vol. xii.
405. Cassava Bread from Dampier's Straits. Donor J. Bell, Esq. As. Journ. Vol. v. p. 517.

Curiosities and Sundry Articles.

406. A Lama's Thigh-bone (in the form of a flute.)
407. Specimens of mud casts of the Lingam, which are worshipped by the Hindus, while performing their ablutions.
408. Model of a Granary.
409. Fragment of the tusk of an Elephant with a ball.
410. A piece of Planking and Copper Sheathing from the bottom of the Ship *Adele*, pierced by the horn of Narwhal on her voyage from Penang to Akyab, on the 24th January, 1833.
411. Copper from the bottom of the Ship *Guide*, struck by lightning while in dock. Donor J. M. Seppings, Esq.
412. Cover of a box.
413. Specimens of Horse Shoes.
414. Specimens of Malacca Tin, presented by Lieut. Newbold. 1835.
415. Malayan Head-dresses, presented by Gen. Hardwicke. As. Res. Vol. xii.
416. Two Malayan Pipes.

Musical Instruments.

NEPALESE.

1-2-3. Horns, called in Hindee Bhorang. Donor M. S. Bramley, Esq.
4. Bass Horn, of copper, called Singha. Donor ditto ditto.
5-6-7. Hautboys, or Sanáis. Donor ditto ditto.
8. Trumpet, or Phonga, Newari. Donor Dr. A. Campbell.
9-10. Flageolet, or Mohalli. Donor ditto ditto.
11-12. Hörns, or Singha, Nepal. Donor ditto ditto.
13. Nug Pheni, or Turi, Parbattiahs. Donor ditto ditto.
14. Bansuli, Flute or Fife. Donor ditto ditto.
15. Beli, or Krisna-beli, Newari flute. Donor ditto ditto.

COLE COUNTRY.

16. Tampoorah, used by the hill people near Hazaribagh. Donor Lieut. J. Audry.
17. Ektarraw ditto ditto Donor H. H. Wilson, Esq. Donor Baboo Ramcomul Sen.

BENGALESE.

18. Khartala. Donor H. H. Wilson, Esq.
19. Gojee. Donor ditto ditto.

20. Doobdoobi.
21. Been Setara.
22. Setara.
23. Serang.
24. Sarinda.
25. Bank.
26. Bhorang.
27. Bansuli.
28. A pair of Kartala.
29. A ditto small ditto.
30. A pair of Mandira.
31. Jhanj.
32. Kansara.
33-34. Sanayis.
35. Dhola.
36. Dholaka.
37. Jaraghayi.
38. Tasa.
39. Dagara.
40. Kada.
41. Ram-a-Kada.
42. Dhamsha.
43. Tikaras.
44. Jayadhak.
45. Mridanga.
46. Madala.
47. Pakwaz.
48. A pair of Tabla.
49. Dampa.
50. Dara.
51. Khanjaris.
52-53-54. Sanayis.

CHINESE.

55. Flute. Donor, Dr. R. Tytler.

BURMESE.

56-57. Fiddles.
58. Harp.

UNIDENTIFIED.

59. A double Flute or Fife.
60. A Fiddle.
61. A Bamboo Flute.
62-63. Bamboo Flutes.

Armour and Weapons.

a. Nepalese.

1 to 4. Swords. Donor, B. H. Hodgson, Esq.

5 to 12. Swords.

13-14. Sword, Kukri and Khonta. Donor Genl. Bhima Sinha, Journ. As. Soc. Vol. v. p. 56.

15. A Dagger. Donor ditto ditto.

16-17. Daggers.

b. Orissa.

18. Battle Axe. Donor J. G. Balmain, Esq.

19. Six Arrows from the hills of Kuttuck, used by the Paiks. Donor ditto ditto.

c. Naga.

20-21. Spears. Donor Mr. Milne.

22-23. Swords. Donor ditto ditto.

24-25. Battle Axes. Donor ditto ditto.

26-27. Swords.

28. War Cap, worn by the chiefs. Donor Mr. Milne.

d. Hindustani.

29. Sword dug up from six feet under the bed of the Jumna river. Donor Lieut. Burt.

30 to 35-36. Cut-an-thrust sword. Donor H. Torrens, Esq. As. Journ. May 1842.

37 to 41. Copper Weapons found in the earth near Futtehgerh. Donor T. Williams, Esq.

42. Copper Dagger.

43 to 46. Daggers.

47. Copper Head of a Spear. Donor Capt. Presgrave.

48 to 51. Blades of Spears.

52 to 65. Spears, (silver mounted.)

66-67-68. Spears, (brass mounted.)

69 to 74. Spears, (plain ones.)

75. Matchlock. Donor W. L. Gibbon, Esq.

76. A single barrel Gun, with double lock. Donor Lieut. Anderson.

77 to 82. Battle Axes.

83-84-85. Chain Shirts.

86-87. Chain Collars.

88 to 91. Iron Breast Plates.

92 to 95. Ditto Plates for the back.

96. Ditto Helmet.

97. Ditto ditto, covered with iron net.

98. A Cap.

99-100. Two Gauntlets.

MERGUI.

101-102. Shields used by the warriors.

103. Helmet.

104. Brass Collar.

105. A pair rattan Cases, worn on the legs, under the slight bamboo rings, to give the calf a large appearance.

ASSAM.

106. Sword. Donor Dr. L. Burlini.

107. Bhotian Standard, carried before the King in war. Donor Capt. Bogle.

CHOTA NAGPORE.

108-109. Iron Shields.

110. A brass Shield. Donor G. W. Hamilton, Esq.

111. Chok-krow.

BURMESE.

112. Sword, with silver mounted scabbard and handle.

113. War-hat, worn by the Singphos. Donor Col. A. Burney.

MALAYAN.

114. An ornamented Spear. Donor Capt. M. Kittoe.

115. Lahore Matchlock, purchased from one of Runjeet Singhs' Jhounhurras. Donor H. Torrens, Esq. As. J. May 1842.

116 to 17. Two Peshawer fire-locks, mounted, one after the Native and one after the English fashion; the locks made by Cashmeree Gunsmiths of Ludiana, to imitate Towerlocks. Donor H. Torrens, Esq. May 1843.

118. A Gun. Donor ditto ditto.

119. A Knife used by the Tribes about the Khyber Pass, or Afreddees, Momunds, &c. Donor ditto ditto.

120. Pirate's Dart Tube. Donor Lieut. C. Mackenzie. Journ. As. Soc. Vol. v. p. 517

121. Ditto ditto, with a blade answering for spear.

122 to 124. Swords.

125 to 127. Krises.

128. Malay Pirate's Quiver, containing poisoned darts. Donor Lieut. Mackenzie.

129. Ditto ditto, containing poisoned darts and small arrows.

130. Spear with double blades.

131-132. Spears, (brass mounted.)

133. Spear.

134 to 139. Spears.

140 to 141. Ditto.

142 to 147. Ditto.

CHINESE.

148. Sword from Amoy. Donor H. Torrens, Esq.

149. Chain-shot, with chain enclosed, from Chusan. Donor ditto ditto.

150. Standard from the Bogue Fort. Donor ditto ditto.

151-152. Two Bows, (deposited.)

153. A Quiver, with 30 arrows, (ditto.)

154. A three barrelled Pistol, found in the Chief Commissioner's house at Chusan, October, 1841. Donor J. C. Hutchinson, Esq.

155. A Cross Bow found in the Gun Carriage Manufactory, Chinhae, October 1841. Donor ditto ditto.

156. A Quiver from Chusan, taken August, 1840. Donor ditto ditto.

157. A Tartar Bow from Ningpo. Donor ditto ditto.

158. Eleven Arrows, taken from the Arsenal in Chusan, August 1840. Donor ditto ditto.

159. A Helmet of a Tartar Soldier, taken from the Arsenal in Ningpo. Donor ditto ditto.

SOUTH SEA ISLANDS.

160 to 163. Spears.

164 to 173. Clubs from the Friendly and Feejee Islands. Donor Capt. Dillon. As. Res. XV. App. 9.

174. Club from New Zealand. Donor ditto ditto.

175 to 173. Manicolo Clubs. Donor ditto ditto.

174 to 198. Clubs.

199. Paddles and Oars.

200. Battle Axe of whale-bone, answering to a carving knife, from New Zealand. Donor Capt. P. Dillon.

201-202. Green Zade (Axe-stone) Battle Axe. from ditto ditto. Donor ditto ditto.

203. Stone Battle Axes. Donor ditto ditto.

204 to 205. Stone Battle Axes from Mangeer a Island. Donor ditto ditto.

206. Stone Battle Axe, from New Zealand.

207. Copper Shield.

208. Wooden Shield.

EUROPEAN.

209. Sword of Her Highness The Begum Sumroo, which she had worn from the year 1778, to the day of her death, and which was always kept by her bed-side. Donor Mr. Dyce Sombre.

210. Spauish Gun.

Read the following letter, dated Paris, 2nd February, 1843, from Major A Troyer:—

Paris, 2nd February, 1843.

MY DEAR TORRENS,—I had the pleasure of sending you a letter by Baboo Dwarkanath, who must have arrived in Calcutta sometime ago. Now, I avail myself of the opportunity offered me by Mr. Oatley, of the Madras Cavalry, who goes to India via Marseilles and Suez, &c.

In my last letter to you, I touched upon some points, upon which I shall be very happy to receive a few lines from you. How is the copying of the Vedas for the French Government going on? It is now a considerable time since the Asiatic Society of Paris has not received the least communication from you. You cannot imagine what pleasure every thing which comes from Calcutta, causes here in Paris. No. 123 is the last No. of your Asiatic Journal which we received. The political and military affairs in India having now taken a very advantageous turn, it may be expected that some more attention will be bestowed upon peaceable and literary pursuits by some of the many distinguished individuals who live in India. Will you have some more leisure to give us some tract of yours, or a priuted edition of some oriental work? Mr. Brookhaus is a very respectable Sanskrit scholar, who sent you some time ago his edition of the *Vrihat Kutha*, with a German translation; he is since several years occupied with the study of Indian tales, and would be very happy to see an edition of the whole Sanscrit work published in Calcutta. I suppose Professor Wilson wrote to the Society about this subject, and recommended it to you as a very laudable undertaking. As to my own occupation—I can but repeat to you that I am still busy here in Paris with the printing of the English translation of the Dabistan, in three volumes, which I hope to be able to terminate in the course of this year. In my

last letter I took the liberty to request you to propose to the Society, the nomination of M. Julius Mohl as an honorary member; I beg to repeat my request, on the risk of being thought very intrusive, but not without hope to be excused and pardoned by you. The communication between India and France by the way of Egypt having become so easy and rapid, we may flatter ourselves to hear a little more frequently of you, and of the Asiatic Society of Calcutta; with this flattering hope, let me offer you my best wishes for the continuation of your health and happiness. Yours most truly,

A. Troyer.

Read the following report from the Curator of the Museum Economic Geology, for the month of March 1843.

Report of the Curator Museum of Economic Geology, for the month of March.

Museum of Economic Geology.—I have the pleasure to announce in this month the discovery of copper ore on Round Island, a small islet off the S. E. end of the Island of Cheduba. The specimens exhibited were forwarded from Ramree by Captain D. Williams, Principal Assistant to the Commissioner of Arracan, who states that they were discovered by a Mug named Neokein, whom he had employed to search for coal. They consist of nodules of native copper, with red and black oxide and silicate of copper. The absence of the sulphurets or arseniates which I have not yet found amongst the specimens, render the ore of a very valuable kind, and if abundant, it will be of much importance. So pure is it, that Captain Williams sends with it a ring made from it by a native workman, which is on the table with the specimens. I have written to him for more abundant supply, and for details on the nature of the vein, rocks, and any other associated ores or minerals which may be found with it, from which some idea of its value as a mining site may be deduced, and due report made, to Government on the subject.

Copper Ores.

No. 1604.

Ramree, Arracan, March 7, 1843.

My dear Sir,—I now do myself the pleasure of submitting to you, the information you require regarding the copper ore I sent you.

It was obtained on Round Island, which on reference to a chart of this coast at the Marine Board Office, you will find to be an island on the East Coast of Chedooba Island, a little North of Flat Island. There is fresh water on the island, and ships may anchor close to it; plenty of fuel procurable at the spot. The ore was found by digging

for it, and I hope soon to be able to send you specimens of the rock and soil in which it is imbedded.

With regard to the volcano: on a former eruption I forwarded a specimen of a fish thrown up by the volcano, (so the natives say,) to the late Mr. Prinsep, which is now in the Museum of the Society.* The volcano hill is close to Kyouk Phyoo, and Mr. Howe will no doubt forward to you what you want.

Yours truly,

D. Williams.

I forward all the copper ore I can *now* procure from Neokein. He will proceed to dig for more, and bring specimens of the earth and stones.

Having addressed the Sudder Board of Revenue N. W. P. as follows:—

The Secretary of the Sudder Board of Revenue, N. W. P.

Sir,—I am directed by the Committee of Papers of the Asiatic Society to request you will be pleased to submit to the Board, or to the proper authorities, their application for a complete set of the Revenue Survey Maps of the various districts under the Government of Agra, for the use of the Museum of Economic Geology of India, of which the objects are briefly detailed in the circular herewith.

2. As also that the Board will be pleased to assist the objects of the institution by distributing to its various officers the accompanying circulars (of which more will be sent if desired) with its recommendation of their object, as being a matter of the highest import to the financial interests of the country.

I have the honor, to be, &c.

Asiatic Society's Rooms,
The 23rd Feb. 1843.

(Signed) H. Piddington,
Acting Secretary, Asiatic Society,
and Curotor Museum Economic Geology of India.

I received the following reply, and the district Maps sent are now upon the table. Our best thanks are due to the Board for its very liberal assistance, and I anticipate with confidence, from the numerous opportunities which its officers have before them, many important additions to our stores.

No. 31 of 1843.

From H. M. Elliot, Esq. *Secretary to the Sudder Board of Revenue, N. W. P. Allahabad, to* H. Piddington, Esq. *Acting Secretary Asiatic Society of Calcutta.*

Sir,—I have the honour to acknowledge the receipt of your letter of the 23rd

* I regret to say that it cannot be found.—H. P.

ultimo, and to inform you that as requested therein, a set of the Lithographed Maps noted below has been forwarded to your address for the Museum of Economic Geology.

2. The Printed Circulars, received with your letter, have been distributed to Commissioners of Divisions.

I have the honor, to be, &c.

Sudder Board of Revenue, N. W. P.
Allahabad, the 14th March, 1843.

Your most obedient servant,
H. M. Elliot, *Secretary.*

List of Maps.

1 Map of Ghazeepoor, on Drawing Paper, colored.
1 ditto ,, Benares, ditto.
1 ditto ,, Jaloun, ditto.
1 ditto ,, Jounpoor, ditto.
1 ditto ,, Allahabad, ditto.
1 ditto ,, Futtehpoor, ditto.
1 ditto ,, Cawnpoor, ditto.
1 ditto ,, Humeerpoor, ditto.
1 ditto ,, Bandah, ditto.
1 ditto ,, Agra, ditto.
1 ditto ,, Etawah, ditto.
1 ditto ,, Muttra, ditto.
1 ditto ,, Furruckabad, ditto.
1 ditto ,, Barreilly, ditto.
1 ditto ,, Bijnour, ditto.
1 ditto ,, Shahjehanpoor, ditto.
1 ditto ,, Moradabad, ditto.
1 ditto ,, Budaon, ditto.
1 ditto ,, Pillibheet, ditto.
1 ditto ,, Delhi, ditto.
1 ditto ,, Paneeput, ditto.
1 ditto ,, Hurrianah, ditto.
1 ditto ,, Goorgaon, ditto.
1 ditto ,, Bhutteeanath, ditto.
1 ditto ,, Meerut, ditto.
1 ditto ,, Boolundshuhur, ditto.
1 ditto ,, Moozuffurnuggur, ditto.
1 ditto ,, Seharunpoor, ditto.
1 ditto ,, Goruckpoor, ditto.

1 Map of Allygurh, on Drawing Paper colored.
1 ditto „ Dehra Doon, ditto.
1 ditto „ Mynpooree, ditto

Mineralogical and Geological Department.—I mentioned in my report of February the notice which I had incidentally received of the brilliant eruptions of the small volcano of Kyook Phyoo, and that I had written to Mr. Howe for details and specimens. These he has very kindly furnished, in replies to my queries, and a chest of specimens of great interest, of which a selection is now on the table.

I am busy examining these, and the results of my work will form a separate paper.

It seems probable, that the mud and the grey shale are nearly the same substance' and the grey shale and brick-red clay slate certainly are so ; for we have one specimen which is grey shale at one end, and brick-red clay slate at the other, with the dark, half calcined-shale in the middle, thus shewing that the metamorphic process had just reached so far. This is not uncommon where dykes have penetrated argillaceous shales ; but I am not aware of any instance in which it is known to be actually going on as it here appears to be, except that it may be supposed to be so in burning coal mines.

Another remarkable singularity in these specimens, which I may briefly notice here, is the low heat of the volcanic flame. Mr. Howe's letter says distinctly, that the station at midnight was rendered as light as day by the flame from the volcano though at 3 or 4 miles distance ; and yet we find that the specimens from the sides of the crater are barely calcined, and nowhere approach to fusion. There is no doubt, that the different mud volcanos on Ramree are truly volcanic *fumaroli,** as may be seen by reference to Lieut. Foley's paper in Vol. iv. of our Journal, and the value of this fact consists in the confirmation which it affords of Mr. Lyell's surmise as to the ancient volcanos of the Eifel. I forbear further remarks here, as in our conclusions so much must depend on the mineralogical character of the specimens which are yet under examination.

We have received from Dr. Harlan, the splendid collection of casts of new Missourian fossils, which is now on the table. His letter to our associate Dr. Huffnagle, who has placed it in my hands as Officiating Secretary, is as follows :—

Philadelphia, July 21, 1842.

Dear Sir,—It is a long time since I have had the pleasure of hearing from you directly, and an opportunity now offering from our port, I seize the occasion to address you, and of forwarding through you, a collection of the casts of fossil bones found in Missouri, and of which I have made a new genus of extinct quadrupeds ; a printed notice of these bones accompanies them, as also some other specimens duly labelled, which I beg the Asiatic Society to accept from me as a slight testimony on my part, to the liberal manner they treat their foreign members. I have been absent

* Though not affording sulphureous or saline exhalation.

two years in Europe since I heard directly from you, and on examining my copies of the Asiatic Journal, I find the following numbers have never reached me; viz. 77, 78, 79, 81, 82, 83, 86, 87, 88, 89, 90, 97, 98, 99.—No. 113, is the last come to hand; perhaps you could by application, obtain for me the completion and perfection of my copy of this valuable publication. And if you could aid me by sending for my cabinet any specimens in the department of Comparative Anatomy, you would confer a great favour. I was so unfortunate, during my absence in Europe, as to lose all my anatomical collections by fire, the labour of twenty years. The Professors of the Garden of Plants in Paris, on receiving intelligence of my great and irreparable loss, presented me with a very fine nucleus to form another cabinet, and I am emboldened to ask assistance of all my friendly Correspondents.

A full account of my new fossil bones, *Orycterotherium Missouriensis*, is not yet published, as it will be I hope soon with plates, when I shall not fail to send copies to foreign Correspondents.

As regards specimens in Comparative Anatomy for my cabinet, which is intended to illustrate a series of lectures on Comparative Anatomy and Physical History of Man, any bones, fossil or recent, or casts of them, would not come amiss, but I am particularly desirous to obtain skulls and teeth. R. Harlan.

The following Gentlemen were proposed and elected as Members of the Committee of Papers, for the current year 1843; viz.

Vice-Presidents.

Right Rev. the Lord Bishop of Calcutta.
Sir J. P. Grant.
Sir H. W. Seton.
H. Torrens, Esq.

Members.

Lieutenant Colonel W. N. Forbes,
W. P. Grant, Esq.
Lieut. A. Broome of the Horse Artillery.
C. Huffnagle, Esq.
Dr. J. Hæberlin.
N. B. E. Baillie, Esq.
S. G. T. Heatly, Esq.
Baboo Prosono Coomar Tagore.

For all the presentations and contributions, the thanks of the Society were accorded to the Donors.